UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
7600 Sand Point Way N.E.
Seattle, Washington 98115

March 27, 2015

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Bureau of Reclamation
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Sacramento, California 95825

Mr. Mark Cowin
Director
California Department of Water Resources
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Sacramento, California 95814

Re: Contingency Plan for Water Year 2015 Pursuant to Reasonable and Prudent Alternative Action I.2.3.C of the 2009 Coordinated Long-term Operation of the Central Valley Project and State Water Project Biological Opinion

Dear Mr. Murillo and Mr. Cowin:

This letter is in response to your March 24, 2015, letter and enclosures: (1) a Project Description for April - September 2015 Drought Response Actions To Support Endangered Species Act Consultations [Project Description, which includes modifications in a Temporary Urgency change Petition (TUC Petition) to the State Water Resources Control Board (State Board)]; and (2) a Biological Review for Endangered Species Act Compliance with the WY 2015 Drought Contingency Plan April through September Project Description (Biological Review). Based on Reclamation's March 24, 2015, transmittal letter, the Project Description, and the Biological Review, the following summarizes the U.S. Bureau of Reclamation's (Reclamation) and California Department of Water Resources' (DWR) proposals for NMFS concurrence under the Reasonable and Prudent Alternative (RPA) Action I.2.3.C in NMFS' June 4, 2009, biological and conference opinion on the long-term operation of the Central Valley Project (CVP) and State Water Project (SWP; CVP/SWP Opinion):

1. Modification of Net Delta Outflow Index [Water Rights Decision (D) 1641]
2. Modification of San Joaquin River flow criteria at Vernalis (during "base" and "pulse" flow periods; D-1641)
3. Modification of Export Limits (D-1641)
4. Modifications of Delta Cross Channel (DCC) Gate Operations (D-1641 and CVP/SWP Opinion)
5. Modification of Rio Vista Flow Requirement (D-1641)
6. Modification of Emmaton Salinity Compliance Point (D-1641)
7. Modification of San Joaquin River at Vernalis Salinity Requirement (D-1641)
8. Modification of Ripon Dissolved Oxygen Compliance Point (D-1422)
9. Modification to NMFS IV.2.1 "I:E ratio" Implementation (CVP/SWP Opinion)

The Project Description provides additional details regarding Reclamation's and DWR's requests for April through September 2015, and also identifies a number of potential future requests that would change operations, including some requests that may be necessary if Emergency Drought Barriers are implemented in 2015.

Reclamation intends that the Project Description (including the TUC Petition) and the supporting Biological Review, serve as the drought contingency plan for April through September 2015. Reclamation requests NOAA's National Marine Fisheries Service's (NMFS) concurrence that the drought contingency plan is consistent with the provisions of the CVP/SWP Opinion's reasonable and prudent alternative (RPA) Action I.2.3.C.

We are aware that California continues to face critically dry conditions in the current water year in what has become the State's fourth straight year of below-average rainfall and very low snowpack. Water year 2014 was the fourth driest year in recorded history for California (after 1924, 1931, and 1977 based on the Sacramento Valley water year index), resulting in the low initial storage at the beginning of water year 2015. On December 22, 2014, the Governor of California, through executive order B-28-14[1], reaffirmed his January 17, 2014, Emergency Proclamation regarding California's drought, noting that "the magnitude of the severe drought conditions continues to present threats beyond the control of the services, personnel, equipment, and facilities of any single local government and require the combined forces of a mutual aid region or regions to combat." Since the initial proclamation, NMFS has acted to provide the assistance needed to manage through drought conditions in California. NMFS continues to work quickly and collaboratively with the other fish agencies and the operators of the CVP and SWP to protect health and safety while providing needed protections for and minimizing adverse effects to listed anadromous fish species under the Endangered Species Act (ESA), as demonstrated in the exchange of letters[2] in 2014 and 2015 regarding requested changes in specific operating parameters.

Considering the potential for extremely dry hydrological conditions to occur in California, NMFS built flexible drought provisions into the CVP/SWP Opinion and its RPA. The RPA Action I.2.3.C (pages 26-27 of the 2009 RPA with 2011 amendments[3]) provides drought exception procedures and requires that Reclamation develop and submit to NMFS a contingency plan. The rationale for this action explicitly recognizes that in drought conditions, there is potential for conflict between the need to maintain storage at Shasta Reservoir and other legal and ecological requirements in the Delta, including outflow and salinity standards. This RPA provision is triggered if the February forecast, based on 90 percent hydrology, shows that either the Clear Creek temperature compliance point or 1.9 million acre-feet (MAF) end of September storage at Shasta Reservoir are not achievable.

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[1] http://www.gov.ca.gov/news.php?id=18815

[2] All NMFS letters regarding 2014 and 2015 drought operations are posted online under "Biological Opinion Actions" at: http://www.westcoast.fisheries.noaa.gov/central_valley/water_operations/

[3] http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water%20Operations/Operations,%20Criteria%20and%20Plan/040711_ocap_opinion_2011_amendments.pdf

In response to Reclamation's February 2015 forecast of deliverable water[4], NMFS acknowledged that without additional and substantial precipitation to the Central Valley, California's overall water storage levels will remain below that which would be necessary to supply human needs, repel saltwater intrusion to the Delta, and provide for cold water necessary for listed fish. The end of September 2015 storage in Shasta Reservoir, based on Attachment A of the Project Description, is projected to be approximately 1.174 MAF[5]. The lack of precipitation since the early February storms has only solidified expectations that dry conditions will persist. We agree with your determination that given the current and forecasted hydrology, Reclamation will continue to be unable to meet the Shasta Reservoir storage requirement and maintain Delta outflow and water quality standards requirements pursuant to D-1641, and that Action I.2.3.C remains in effect.

On January 23, 2015, and prior to the RPA Action I.2.3.C requirement, Reclamation and DWR filed a TUC Petition to the State Board that proposed additional technological and operational measures to increase the cold water pool by modifying D-1641 requirements during the months of February and March, 2015. In the March 24, 2015, TUC Petition to the State Board, Reclamation and DWR have renewed their commitment to take necessary actions within their discretion to meet the multiple water needs during this critically dry year, including actions that preserve cold water in Shasta Reservoir to provide for Sacramento River winter-run Chinook salmon (winter-run) habitat needs. The Project Description meets all of the required aspects of the contingency plan required in Action I.2.3.C, as follows:

- Reclamation committed to relaxing the Wilkins Slough flow criterion to at most 3,800 cfs.
- Reclamation has provided an assessment of additional technological or operational measures that can increase the ability to manage the cold water pool.
- Reclamation notified the State Board, through filing the TUC Petition, that meeting the biological needs of winter-run and the needs of resident species in the Delta, delivery of water to nondiscretionary Sacramento Settlement Contractors, and Delta outflow requirements per D-1641, may be in conflict in the coming season.

The Biological Review provides status updates on the abundance and distribution of ESA-listed salmonids and sturgeon covered by the CVP/SWP Opinion, and summarizes the generalized effects of project operations, including the proposed drought flexibilities, on those species and their designated critical habitats. In anticipation of potential high water temperatures in 2014, NMFS developed the winter-run drought contingency plan for 2014 that was included as part of the April 8, 2014, Drought Operations Plan[6]. Even with the successful implementation of the winter-run drought contingency plan last year, winter-run eggs and fry in broodyear 2014 experienced approximately 95% temperature-related mortality. NMFS included this high mortality rate in its juvenile production estimate, and estimated that approximately 124,521 wild

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[4] http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water%20Operations/2015-02-27_nmfs_response_to_bor_s_february_forecast.pdf

[5] The February 90% exceedance forecast provided in footnote 4 indicated that the end of September storage in Shasta Reservoir would be 1.324 MAF.

[6] see Attachment D in http://www.water.ca.gov/waterconditions/docs/2014-0perations-Plan.pdf).

juvenile winter-run from broodyear 2014 would enter the Delta. Based on discussions at the Delta Operations for Salmonids and Sturgeon Technical Work Group (DOSS), as of March 24, 2015, approximately 75% of wild young-of-year winter-run are currently rearing in the Delta, and ~25% have exited the Delta (past Chipps Island).

In addition, Livingston Stone National Fish Hatchery (LSNFH) increased its winter-run broodstock collection in 2014 by three-fold; rearing and releasing approximately 610,000 juveniles into the upper Sacramento River from February 4-6, 2015. The hatchery-produced winter-run juveniles are an important component of the brood year 2014 total population, and therefore, are important to track as they migrate down the Sacramento River, and move through the Delta to the marine environment. All of the hatchery winter-run have been coded-wire tagged and adipose fin clipped, so they could be identified at various monitoring locations within the Sacramento River and Delta. In addition, 571 of the hatchery winter-run juveniles were implanted with acoustic tags as part of an ongoing survival study conducted by the NMFS-Southwest Fisheries Science Center. Using several real-time monitoring stations positioned throughout the Sacramento River and Delta, the movements of these tagged fish can be monitored very closely as they emigrate and rear in the Delta. As of March 24, 2015, about 28% of acoustically-tagged fish have entered the Delta based on at least two detections of each tag at the acoustic receiver in the Sacramento River at Sacramento. This is a conservative estimate. Based on discussions at DOSS, as of March 24, 2015, approximately 70-85% of hatchery young-of-year winter-run are currently rearing in the Delta, and ~25% have exited the Delta (past Chipps Island). Recognizing the considerable contribution of the increased production at LSNFH to brood year 2014, and the expected poor in-river conditions, broodstock collection in 2015 has again been increased.

Inherent in the contingency plan is the objective to meet multiple needs with limited water resources. Most of the negative effects to species identified in the Biological Review (*e.g.*, the potential for reduced survival of outmigrating salmonids from the Sacramento Basin due to modifications to outflow criteria in D-1641) are the consequences of actions intended to result in conditions (*e.g.*, greater Shasta Reservoir storage and a greater cold water pool) that will pre-empt more severe negative effects to species later in the water year (*e.g.*, potentially running out of cold water in Shasta Reservoir to meet the needs of winter-run and Central Valley spring-run Chinook salmon (spring-run) egg incubation and alevin development throughout the temperature management season). Some adverse effects to species identified in the Biological Review (*e.g.*, the potential for increased entrainment of salmonids into the South Delta region due to modifications to export limits) are the consequences of actions intended to result in conditions (*e.g.*, greater south-of-delta storage) that will pre-empt negative effects to anthropogenic beneficial uses of CVP and SWP project water (*e.g.*, municipal and agricultural purposes).

The Biological Review describes the form and trend of effects expected and assigns a qualitative level of certainty to each effect conclusion. NMFS acknowledges that the Biological Review analyzed the anticipated effects of the drought and contingency operations for the remainder of the Water Year (April – September), even though the DSM2 and PTM modeling, on which some of the analysis is based, was limited to the months of April and May. Considering that most of the species under NMFS jurisdiction are presumed to emigrate out of the Delta by mid-June, it

was reasonable to limit the Delta modeling to April and May. Ultimately, quantifying the specific effects of any particular contingency plan element, or of the full suite of proposed modification, is difficult as a result of combined uncertainties relating to:

- specific timing and duration of any particular component of the modification (for example, it is not known when or if the DCC might open, though the opening is allowed under certain conditions);
- specific migration timing of listed species and presence in the "footprint" of any particular modification (for example, a storm in mid-April could trigger migration of the listed anadromous salmonids remaining up-river, which will result in exposure of a greater fraction of those listed anadromous salmonid populations to Delta conditions);
- uncertainty in the quantitative relationship between any underlying factor (*e.g.*, outflow) and the response variable of interest (*e.g.*, survival).

The December 11, 2014, interagency 2015 drought strategy for the CVP and SWP included a biological monitoring plan for water year 2015 and beyond[7]. As part of the biological monitoring plan, the NMFS Southwest Fisheries Science Center (SWFSC) modified ("enhanced") the existing Particle Tracking Model (PTM) module of DSM2 to assign "behavior" to particles. By inserting a number of these particles at select Delta locations into a simulation of forecasted hydrology, the enhanced PTM can provide information on predicted route selection and fate of particles to inform management about various hydrodynamic effects of operations on salmonid movement. The current "behavior" function is based on a preliminary calibration to late-fall-run Chinook movement data in the north Delta. NMFS understands that without further peer-review and validation of the model, this year's pilot application should be used for consideration purposes only, and should not be the sole basis for operational decisions. The enhanced PTM is currently being developed for use in the Central Valley Life Cycle Model[8], however, given the interest in the use of this tool as an element of real-time decision making capacity, the enhanced PTM is being used this water year in a pilot application. The technical documentation is still being developed.

In general, trends from the enhanced PTM are similar to those observed in the PTM results used in the Biological Review, which show that there is a relative increase in the proportion of particles reaching the CVP and SWP during the Project Description hydrology when compared to the baseline (enclosure). Likewise, both the PTM results in the Biological Review and the enhanced PTM results show a decrease in the proportion of particles passing Chipps Island (exiting the Delta) by the end of the model duration for the Project Description hydrology.

The following are NMFS' summaries and expectations based on Reclamation's proposed contingency plan for April through September:

- NMFS supports the March 24, 2015, Project Description, including the March 24, 2015, TUC Petition, as the contingency plan pursuant to RPA Action I.2.3.C.

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[7] http://ca.gov/drought/pdf/DCP-2015-Monitoring-Plan_12-12-14.pdf
[8] https://swfsc.noaa.gov/publications/TM/SWFSC/NOAA-TM-NMFS-SWFSC-530.pdf

- When outflow is greater than 5,500 cfs but less than 7,100 cfs, the combined export limit of 3,500 cfs would only apply to natural or abandoned flow and subject to consensus approval by the real-time drought operations management team (RTDOT) and final approval by the State Board's Executive Director prior to implementation. Combined exports will be limited to 1,500 cfs if reservoir releases are necessary to meet D-1641 or other water quality requirements.
- DCC gate opening prior to May 20, 2015, will only be considered if combined exports are (or will be) at 1,500 cfs and there is a demonstrated need to provide for salinity management in the Delta. If that occurs, Reclamation and/or DWR, through the RTDOT process, will provide at least a 5-day notice to the fish and wildlife agencies so that enhanced monitoring can begin.
- Information related to the operation of DCC gate will be continuously analyzed for changes in risk to species and relative to water quality, including the real-time tracking data for acoustic-tagged hatchery winter-run Chinook salmon, hatchery spring-run Chinook salmon, and wild spring-run Chinook salmon.
- This response does not provide concurrence on the "additional modifications" identified in the Project Description based on possible future conditions. In the event those modifications are deemed necessary, NMFS expects Reclamation and DWR to seek concurrence prior to implementation.
- NMFS expects that the entirety of the Appendix 2-E spring pulse flow, as advised by the Stanislaus Operations Group with subsequent concurrence by NMFS, and as modeled for the Biological Review (Hydrology 2 and 2'), will be implemented.
- NMFS recognizes a modest improvement in the end of September storage of 132 thousand acre-feet (TAF) in New Melones Reservoir (Attachment A of the Project Description), compared to the February forecast submitted to NMFS for consultation[9]. However, NMFS is very concerned about the following potential risks to listed steelhead.
    - The loss of a cold water pool at low reservoir levels, already a concern, may result in in-river releases (from Goodwin Dam) of water at temperatures that may not provide suitable habitat for steelhead and fall-run Chinook salmon.
    - While 132 TAF end of September storage provides water sufficient to meet at least 3 months of water year 2016 Appendix 2-E flows (60 TAF in a critical year; which may require accessing storage behind Old Melones Dam), it may not be sufficient to meet other regulatory or water supply needs after September 2015 if drought conditions continue.
    - Meeting demands after September 2015 may require accessing water behind Old Melones Dam, which raises the following potential concerns:
        - Poor quality of water behind Old Melones Dam (*e.g.*, dissolved oxygen, mercury); and

[9] The February 90% exceedance forecast provided in footnote 4 indicated that the end of September storage in New Melones Reservoir would be 63 thousand acre-feet.

  - Considerable sedimentation in the Stanislaus River downstream of Goodwin Dam.

- The construction and operation of Temporary Emergency Drought Barriers is not considered in this concurrence. If the drought barriers are necessary to lessen water quality impact and meet critical needs, ESA section 7 consultation will need to be completed prior to their construction and operation.
- This response does not provide concurrence on any forecasted operations after September 2015. NMFS expects the Sacramento River Temperature Task Group (SRTTG) to provide additional detail and coordination on the Shasta Temperature Management Plan and spring and summer operations of Shasta Reservoir.
- In order to develop a Shasta temperature management plan, Reclamation and DWR should include a flow schedule for the Sacramento River with specific monthly range of Keswick releases from April through October, an end of May storage target, and an examination of how depletions were analyzed and the consistency of water deliveries to settlement and other contractors with the interim contingency plan.
- Reclamation and DWR should continue to work through the coordinated interagency effort of the SRTTG to describe expected upstream operations, based on 50% and 90% exceedance forecasts. Reclamation should plan its operations throughout the summer and into the fall to minimize, to the extent possible, the amount or extent of winter-run redd dewatering, and also maintain temperature compliance at the Clear Creek California Data Exchange Center gaging station throughout the temperature management season, ending on October 31. NMFS expects that all actions within the anadromous fish section of the WY2015 Biological Monitoring Plan will (continue to) be implemented. Due to the very low viability of this year's winter-run Chinook cohort and the general status of this species as affected by multiple years of drought, we expect Reclamation and DWR to work closely with NMFS to track and assess the real-time distribution of both wild and hatchery juvenile winter-run Chinook salmon and continually assess whether additional measures may need to be implemented to minimize negative effects of operations and the ongoing drought conditions to this critically imperiled species.

In conclusion, NMFS concurs that Reclamation's Project Description is consistent with Action I.2.3.C and meets the specified criteria for a contingency plan. We are making this finding based on both the Biological Review attached to Reclamation's letter, which describes the additional adverse effects of the drought and drought operations, and our conclusion that the potential effects of the types of operations proposed in the contingency plan were considered in the underlying analysis of the CVP/SWP Opinion. The analysis in the CVP/SWP Opinion considered that droughts would occur and concluded that implementation of the RPA, including Action I.2.3.C, is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, California Central Valley steelhead, the Southern Distinct Population Segment of North American green sturgeon, and the Southern Resident killer whales, and will not result in the destruction or adverse modification of their designated critical habitats. Furthermore, the best available scientific and commercial data indicate that implementation of the interim contingency plan will not exceed levels of take anticipated for implementation of the RPA specified in the CVP/SWP Opinion.

We look forward to continued close coordination with you and your staff throughout this extremely challenging water year. If you have any questions regarding this letter, please contact me at will.stelle@noaa.gov, (206) 526-6150, or contact Maria Rea at (916) 930-3600, maria.rea@noaa.gov.

Sincerely,

William W. Stelle, Jr.
Regional Administrator

Enclosure

cc: Copy to file – ARN 151422SWR2006SA00268

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Enclosure

NMFS ePTM results (3/23/15) for TUCP April - September

Model developed by: National Marine Fisheries Service' Southwest Fisheries Science Center (SWFSC)
DSM2 Hydro provided by: California Department of Water Resources (DWR)
Model run and summarized by: NMFS California Central Valley Area Office (CCVAO)

Disclaimer:

These results have been summarized as part of a pilot application of the enhanced Particle Tracking Model (ePTM), which is still under development. The novel "behavior" assigned to passive particles in the ePTM is an attempt to provide a better fit between the PTM predictions and empirical data on fish movement through the Sacramento San Joaquin Delta. The current "behavior" function is based on a preliminary calibration to late-fall-run Chinook movement data in the north Delta; the documentation for which is also still being developed.

Glossary:

Insertion location: refers to a location where the particles are inserted into the model. The insertion location can change based on monitoring information and so as to reflect the current understanding of species distribution.

Scenario: refers to the hydrologic conditions as described in the DSM2 output file which are used as the basis of conditions in the ePTM.

Fate: refers to a particular location at a given time in the model. Some fates are "terminal," meaning once a particle reaches a terminal fate they are removed from the model (i.e. CVP, SWP or exiting the Delta)

Exit: refers to the geographic limit of the model. In the case of the Delta and DSM2, exit refers to those particles that have passed Martinez.

Other Mortality: refers to the proportion of particles that expire during the model run but do not reach a terminal fate (this is a new element of "behavior" added to the ePTM based on reach specific mortality).

In System: refers to proportion of particles that did not reach a terminal fate and did not expire by the end of the model run.

Model parameters:

The model parameters follow the hydrologic conditions described in Table 1 that was provided with Reclamation's Biological Review. Three separate insertion locations were used for the ePTM runs of the Baseline, the Project Description (DCC gate closed), and Project Description (DCC gate open) scenarios during which 1000 particles were "inserted" into the model on April 1. Each model was then run until June 2 (60 days after insertion).

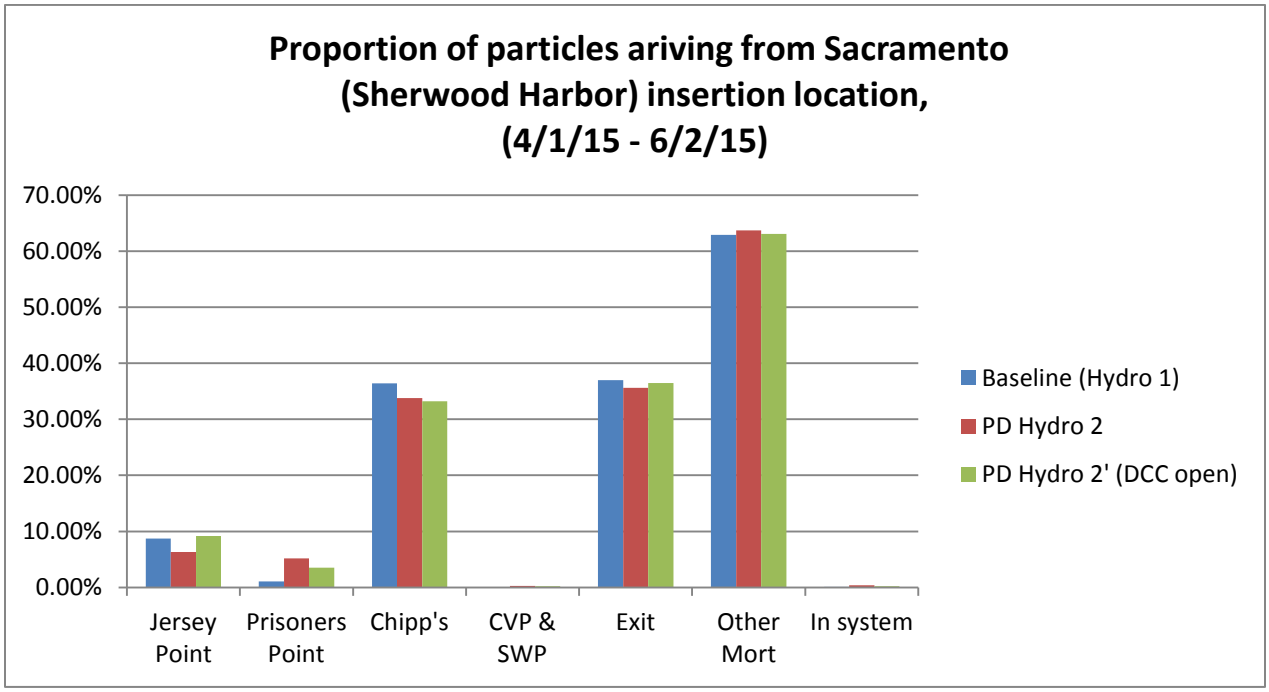
Table 1.DSM2 Model input for scenarios evaluated in the biological review. DSM2 run name is listed parenthetically for each scenario.

Scenario	NDOI		Freeport flow (cfs)		Vernalis flow (cfs)		Combined Exports (cfs)		DCC Status
	April	May	April	May	April	May	April	May	
Baseline (Hydrology 1)	7,100		7,100- (VNS +export)		710 +3100 cfs (4/1 -5/1)		1,500		Closed
Project Description – DCC Gate Closed (Hydrology 2)	4,000		4,000-(Lower VNS +export)		300+App. 2e flow (4/1 – 5/1)[1]		1,500		Closed
Project Description -- DCC Gate Open (Hydrology 2')	4,000		4,000-(Lower VNS +export)		300+App. 2e flow (4/1 – 5/1)[1]		1,500		Open for 2 months

Particle Fate:

Table 1a: Sacramento particle fate as a proportion of 1000 particle "release." Baseline, Project Description (DCC gate closed), and Project Description (DCC gate open) scenarios, April 1, 2015 – June 2, 2015, (60 Days) Insertion: Sherwood Harbor (DSM2 node 332)

Sacramento Insert.	Jersey Point Passage	Prisoners Point Passage	Chipps Island	CVP & SWP	Exit	Other Mort.	In system	Total
Baseline (Hydro 1)	8.70%	1.10%	36.40%	0.00%	37.00%	62.90%	0.10%	100.00%
PD (Hydro 2)	6.30%	5.20%	33.80%	0.30%	35.60%	63.70%	0.40%	100.00%
PD (Hydro 2')	9.20%	3.50%	33.20%	0.20%	36.50%	63.10%	0.20%	100.00%



[1] The TUCP identifies proposed modification of the average monthly flow during the Vernalis 31-day pulse flow period to be no less than 710 cfs.

Table 1b: Central/South Delta particle fate as a proportion of 1000 particle "release." Baseline, Project Description (DCC gate closed), and Project Description (DCC gate open) scenarios, April 1, 2015 – June 2, 2015, (60 Days) Insertion: Middle River at Railroad Cut (DSM2 node 121, SWFSC real time receiver location)

Middle River Inset.	Jersey Point Passage	Prisoners Point Passage	Chipps Island	CVP & SWP	Exit	Other Mort.	In system	Total
Baseline (Hydro 1)	21.90%	14.90%	20.00%	20.10%	19.60%	59.30%	1.00%	100.00%
PD (Hydro 2)	13.30%	15.20%	11.30%	32.10%	10.50%	56.60%	0.80%	100.00%
PD (Hydro 2')	15.10%	15.50%	12.00%	31.70%	11.50%	56.00%	0.80%	100.00%

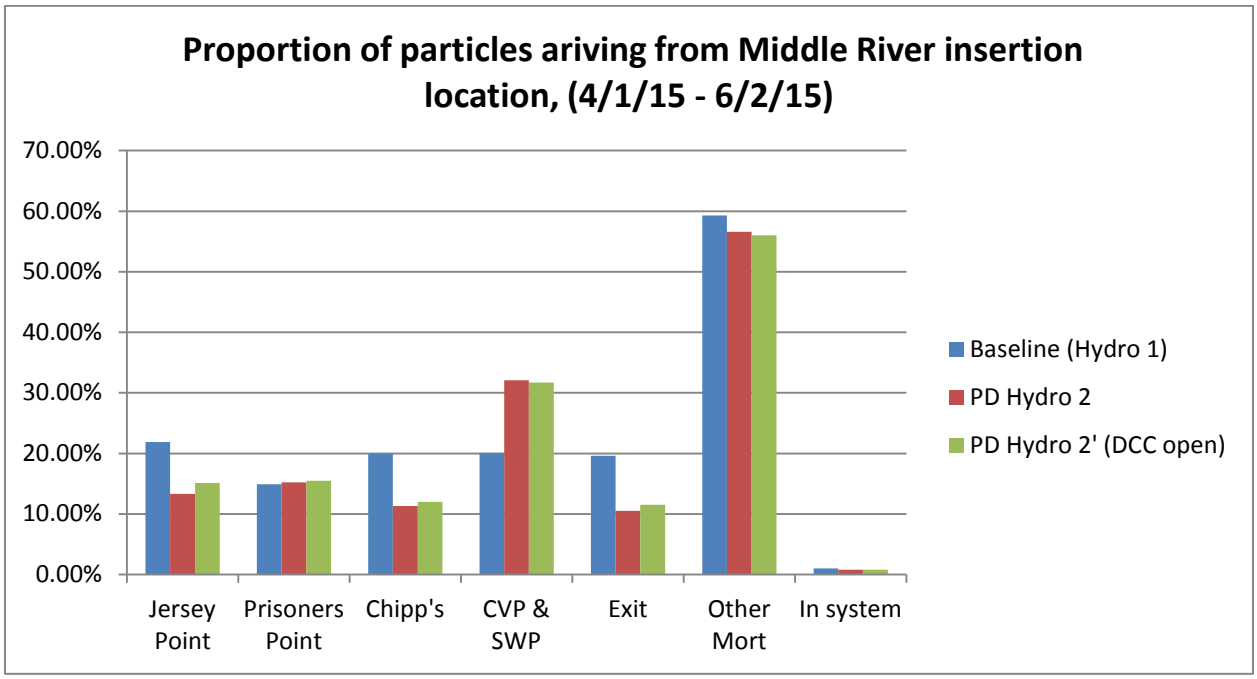
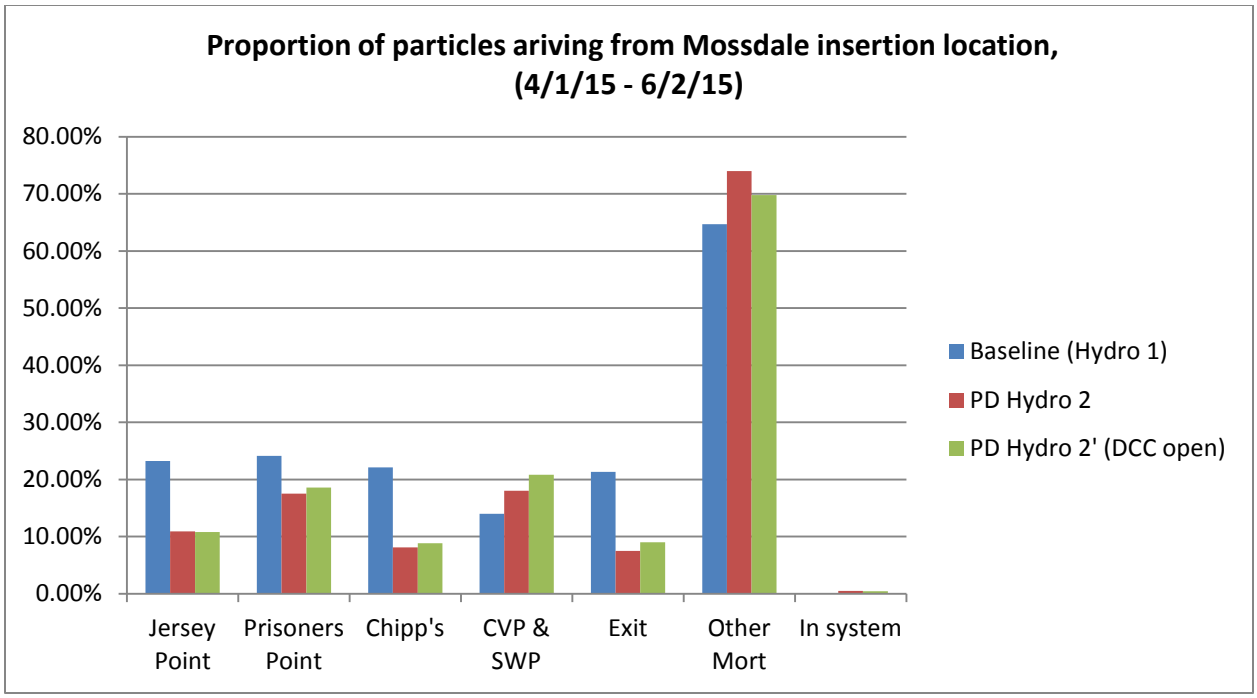
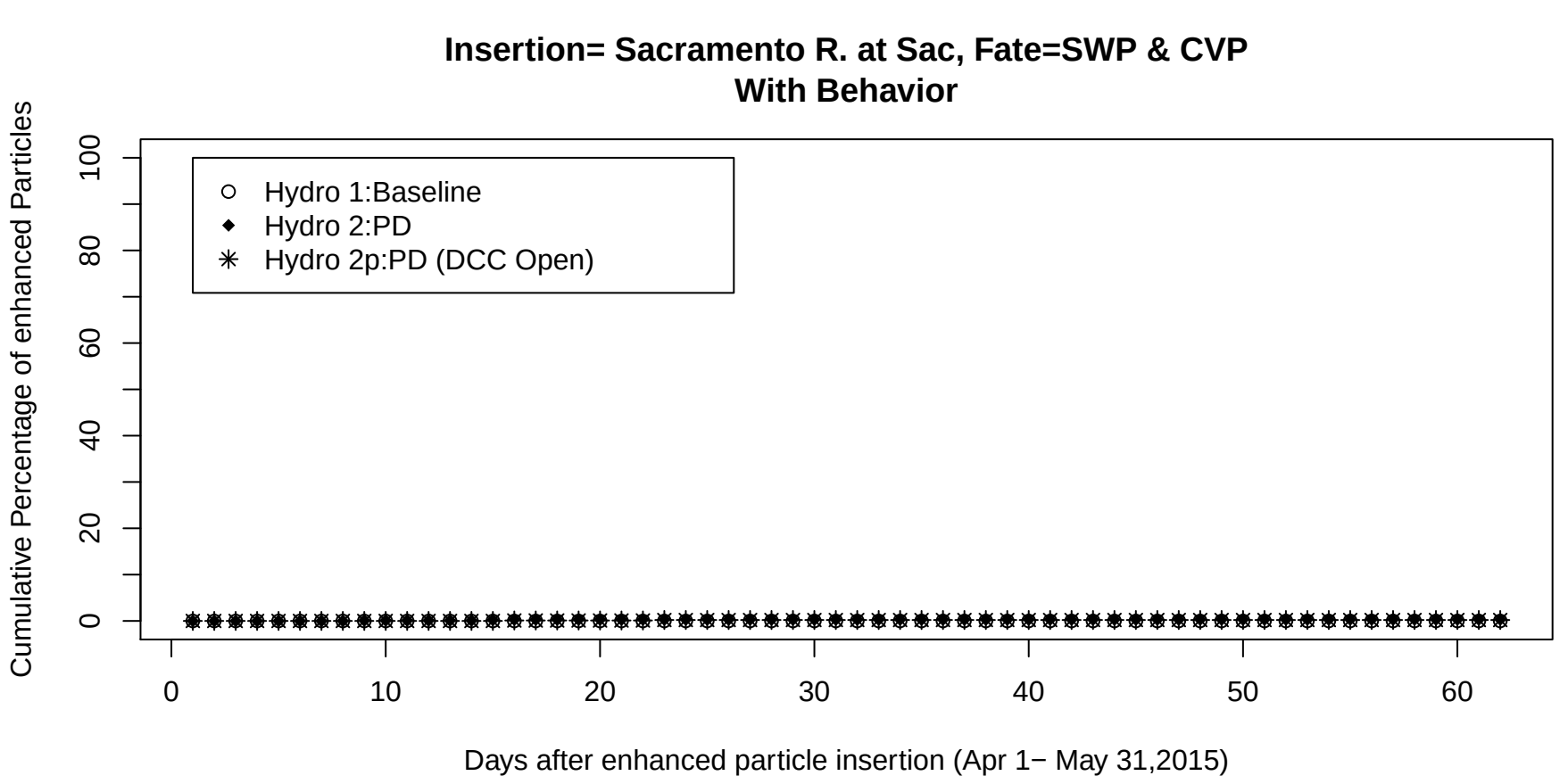
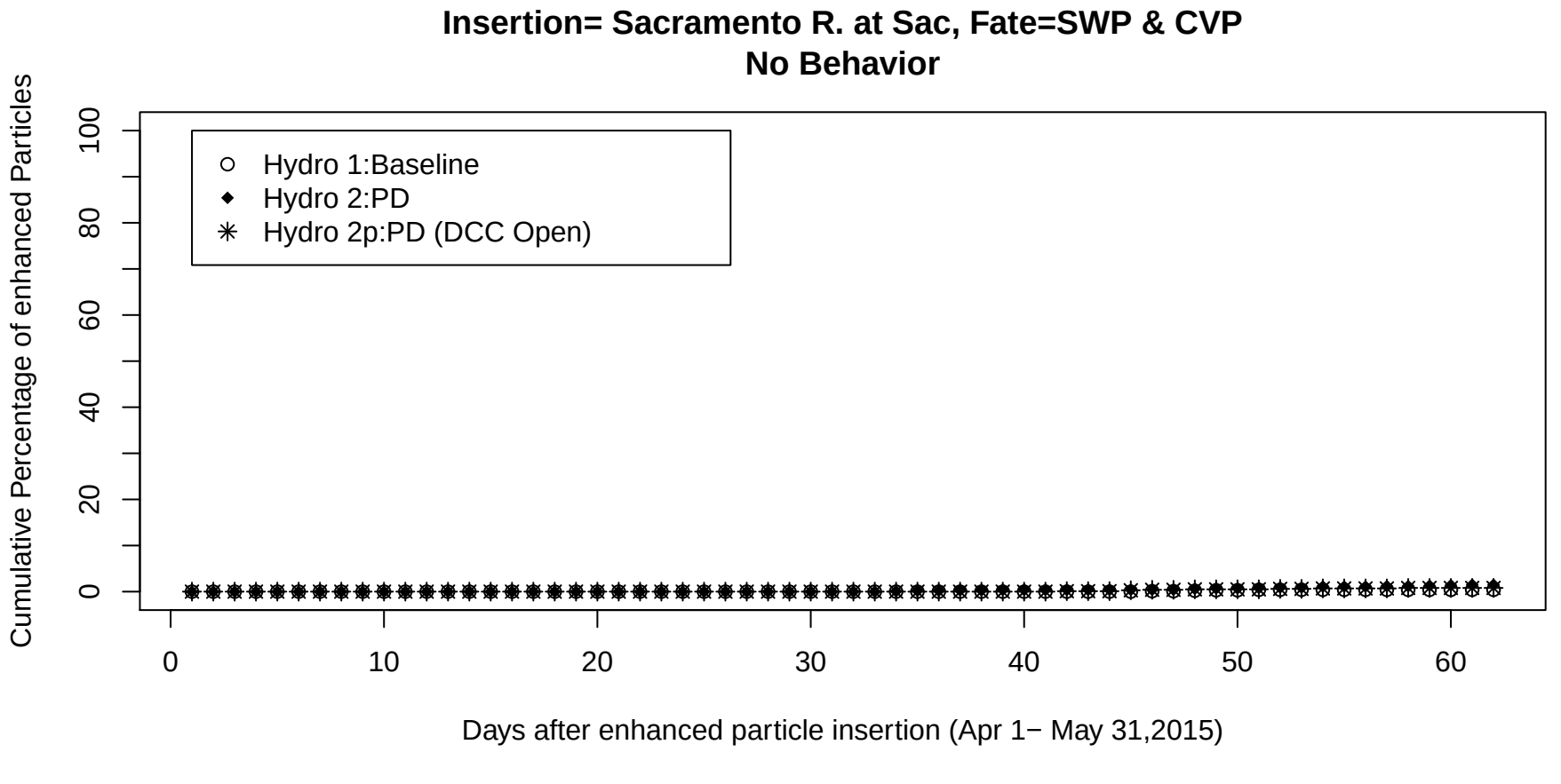


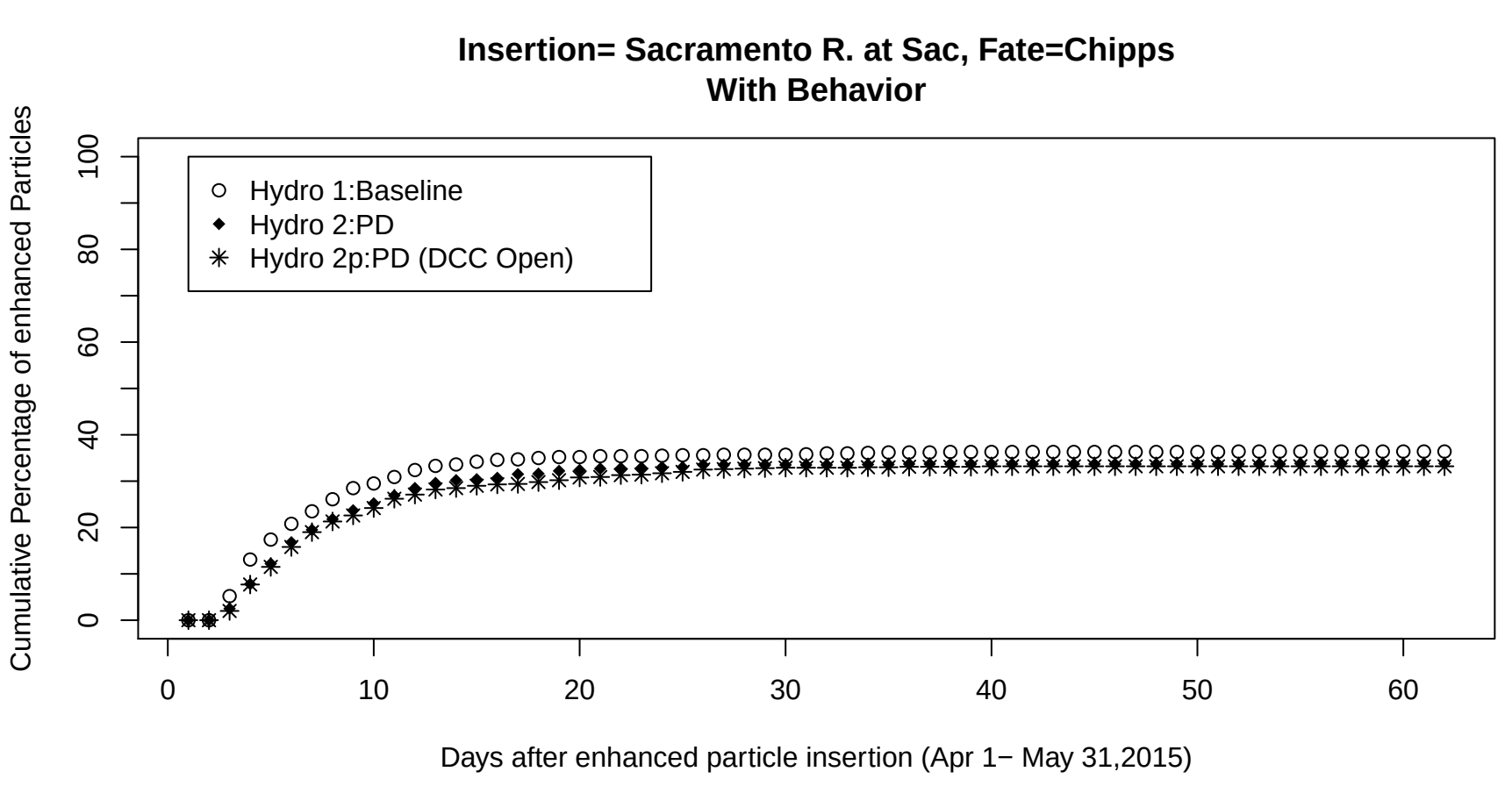
Table 1c: San Joaquin particle fate as a proportion of 1000 particle "release." Baseline, Project Description (DCC gate closed), and Project Description (DCC gate open) scenarios, April 1, 2015 – June 2, 2015, (60 Days) Insertion: Mossdale Crossing (DSM2 node 6)

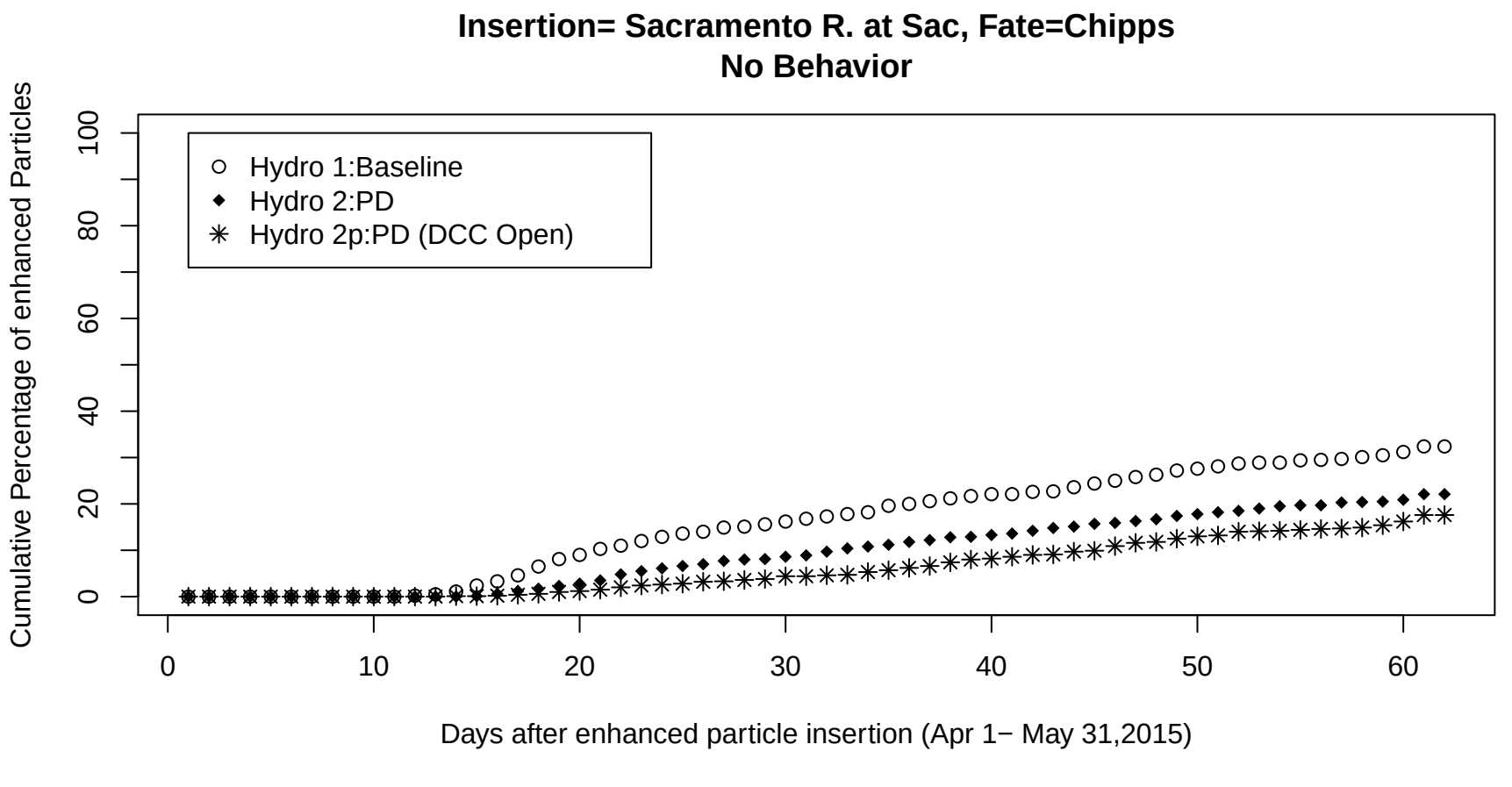
Sacramento Insert.	Jersey Point Passage	Prisoners Point Passage	Chipps Island	CVP & SWP	Exit	Other Mort.	In system	Total
Baseline (Hydro 1)	23.20%	24.10%	22.10%	14.00%	21.30%	64.70%	0.00%	100.00%
PD (Hydro 2)	10.90%	17.50%	8.10%	18.00%	7.50%	74.00%	0.50%	100.00%
PD (Hydro 2')	10.80%	18.60%	8.80%	20.80%	9.00%	69.80%	0.40%	100.00%


Proportion of particles ariving from Mossdale insertion location, (4/1/15 - 6/2/15)
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
Jersey Point
Prisoners Point
Chipp's
CVP & SWP
Exit
Other Mort
In system
Baseline (Hydro 1)
PD Hydro 2
PD Hydro 2' (DCC open)


Insertion= Sacramento R. at Sac, Fate=SWP & CVP
With Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
0
20
40
60
80
100
0
10
20
30
40
50
60
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= Sacramento R. at Sac, Fate=SWP & CVP
No Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
0
20
40
60
80
100
0
10
20
30
40
50
60
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= Sacramento R. at Sac, Fate=Chipps
With Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
0
20
40
60
80
100
0
10
20
30
40
50
60
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= Sacramento R. at Sac, Fate=Chipps
No Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
0
20
40
60
80
100
0
10
20
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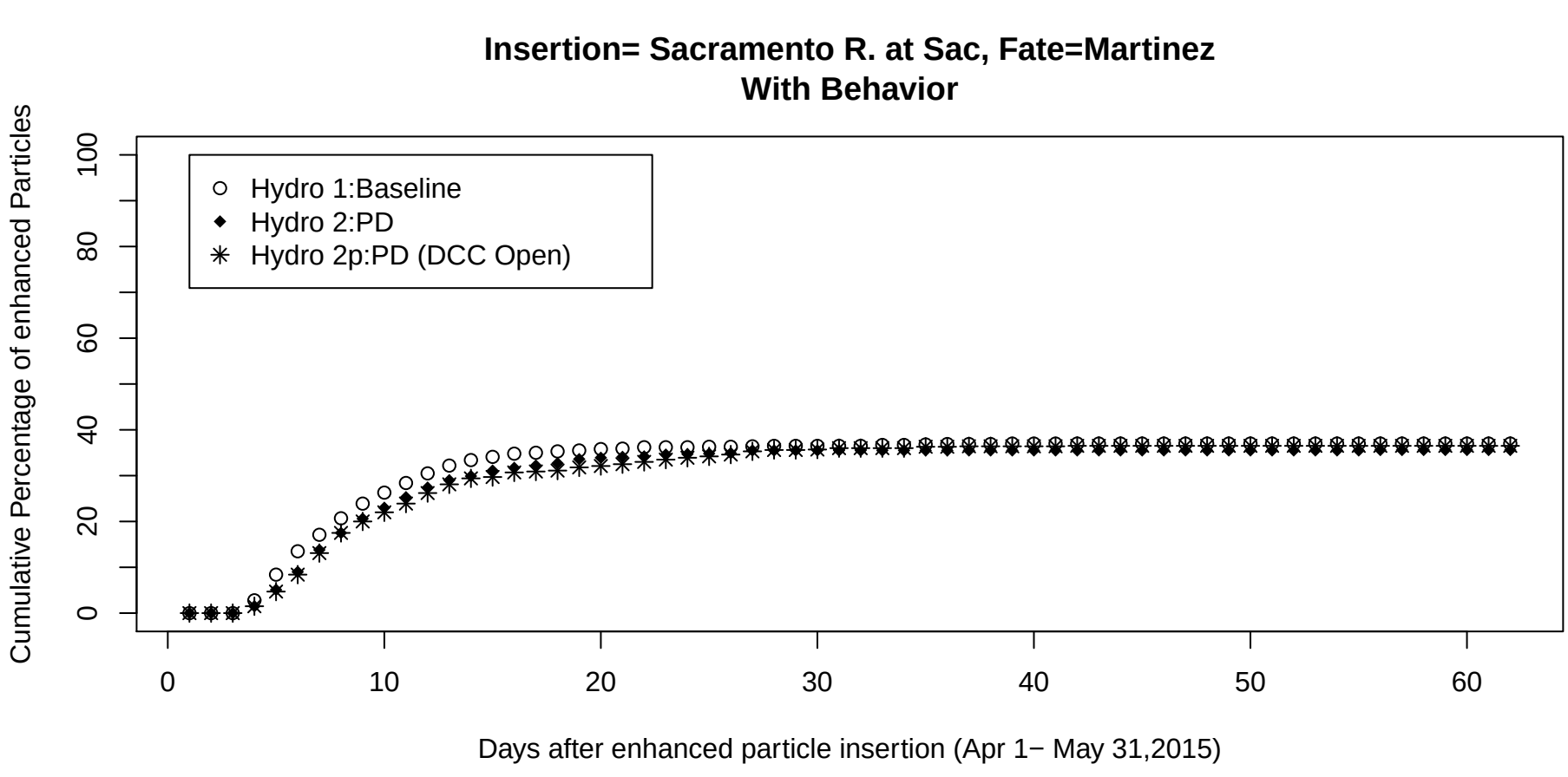
40
50
60
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= Sacramento R. at Sac, Fate=Martinez
With Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
0
20
40
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80
100
0
10
20
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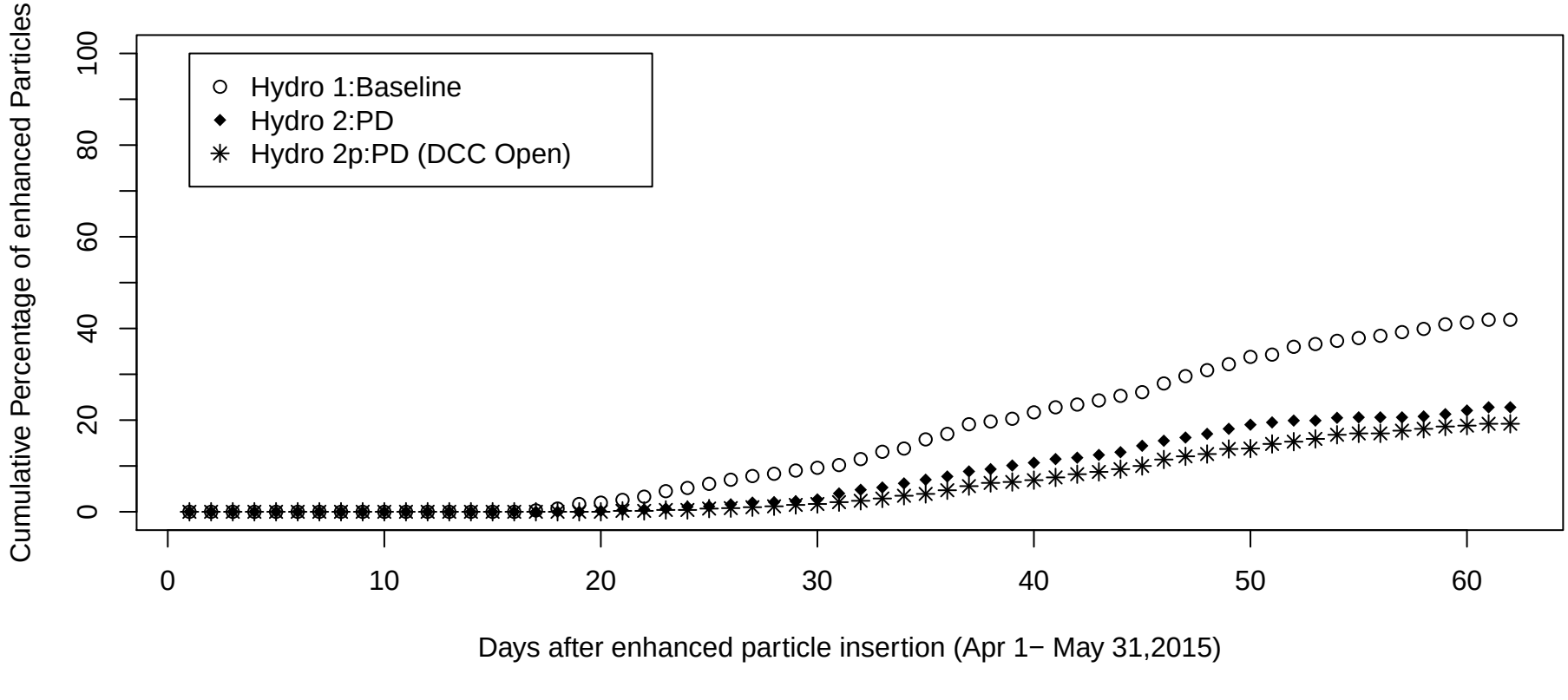
40
50
60
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= Sacramento R. at Sac, Fate=Martinez
No Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
0
20
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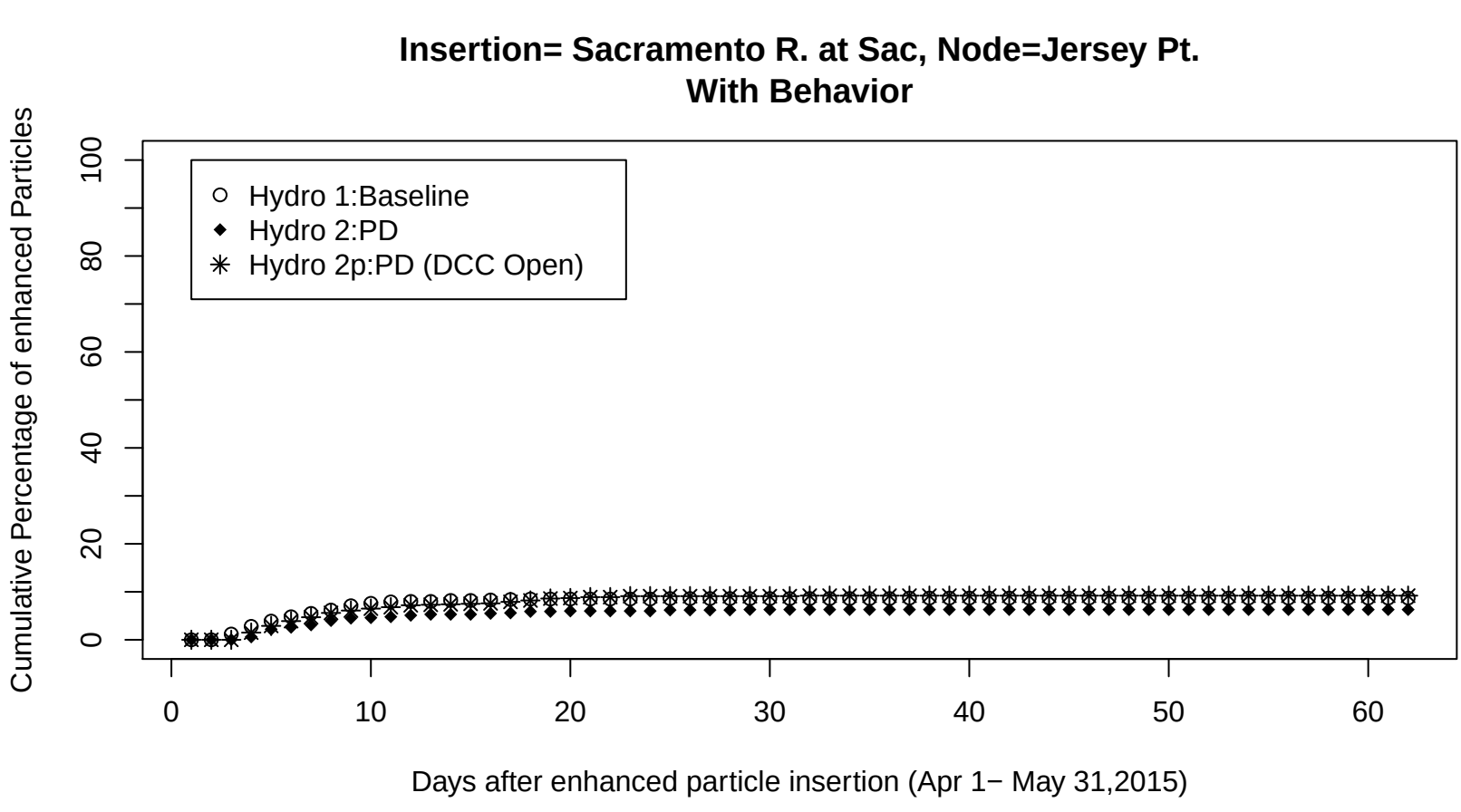
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= Sacramento R. at Sac, Node=Jersey Pt.
With Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
0
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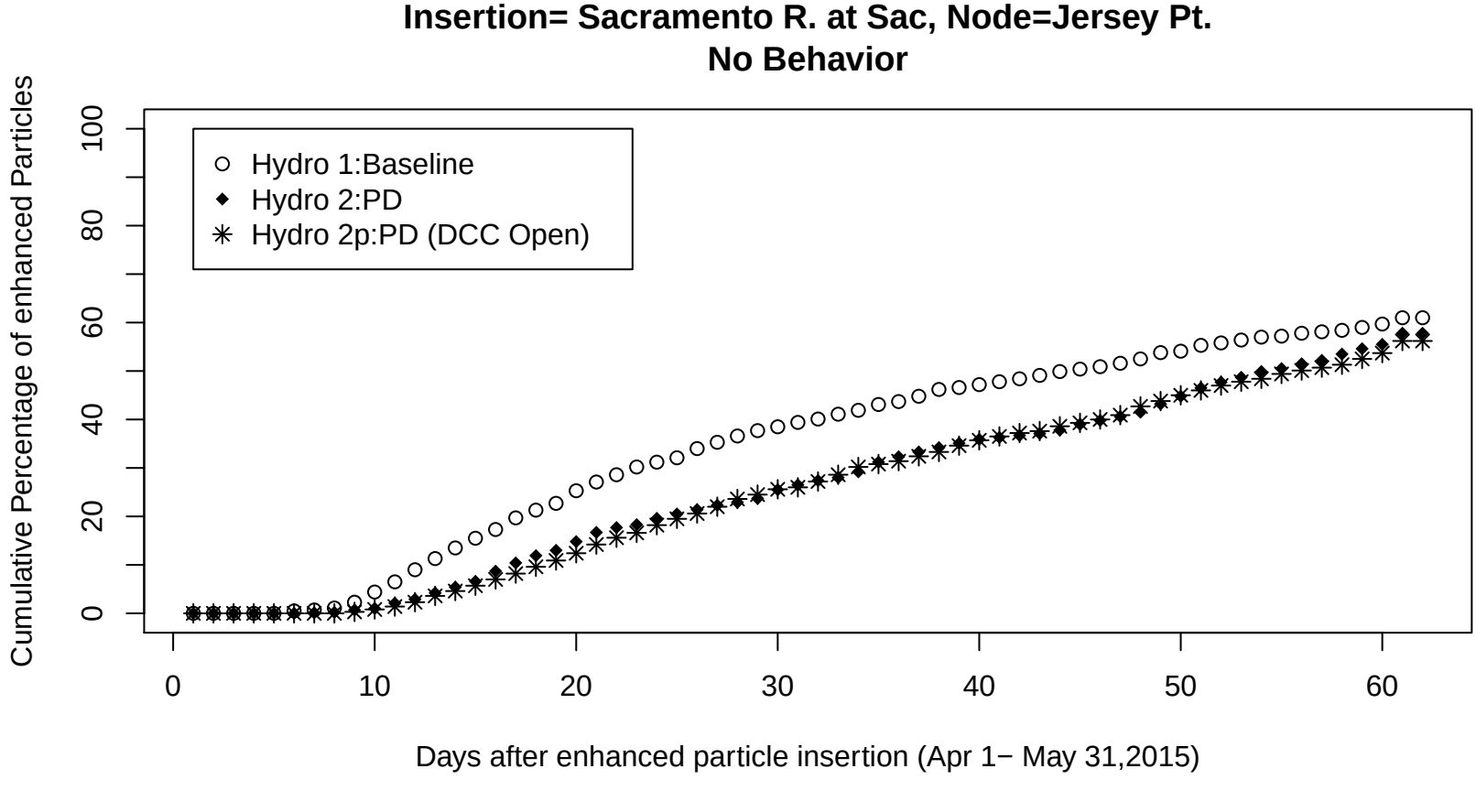
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= Sacramento R. at Sac, Node=Jersey Pt.
No Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
0
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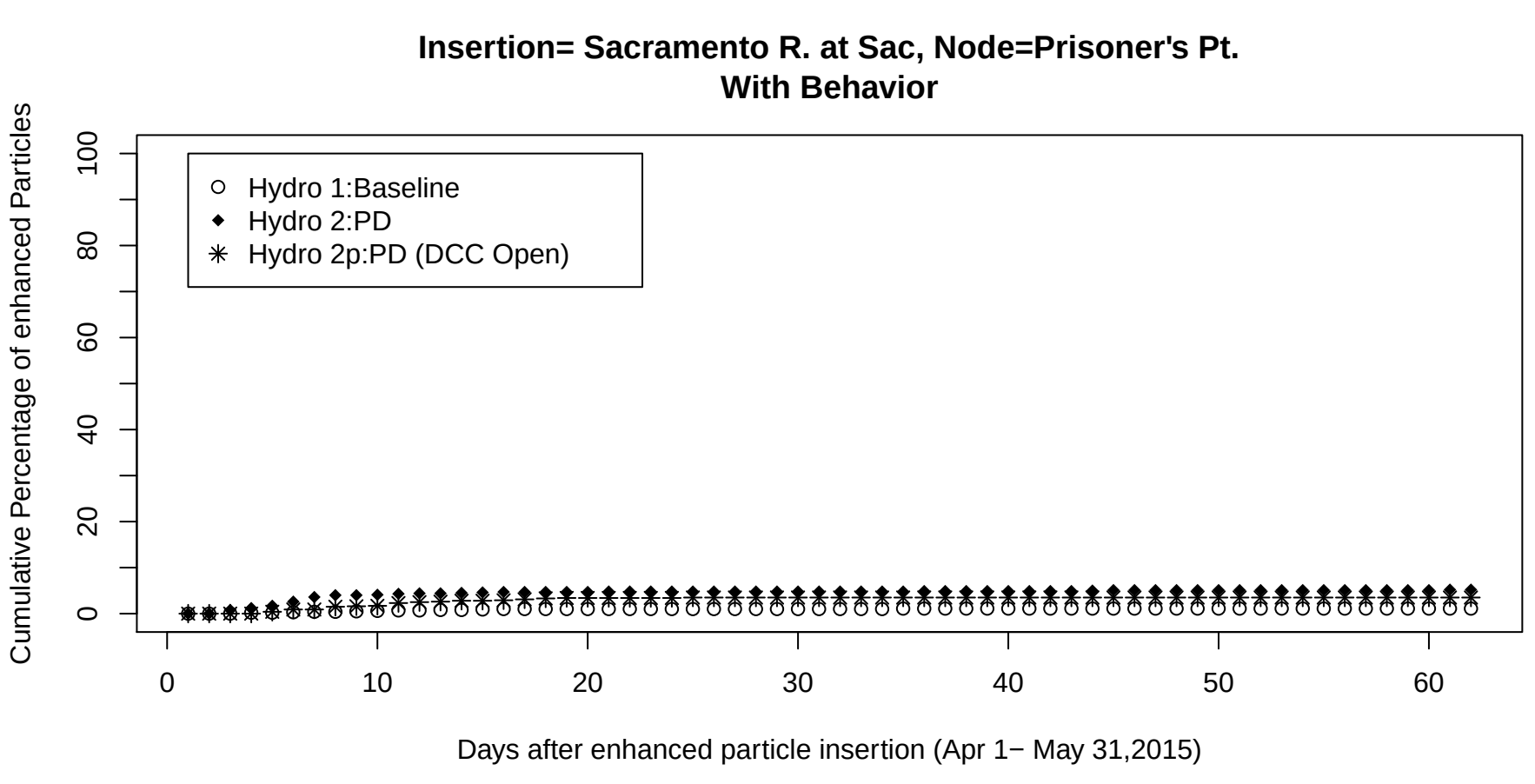
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= Sacramento R. at Sac, Node=Prisoner's Pt.
With Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
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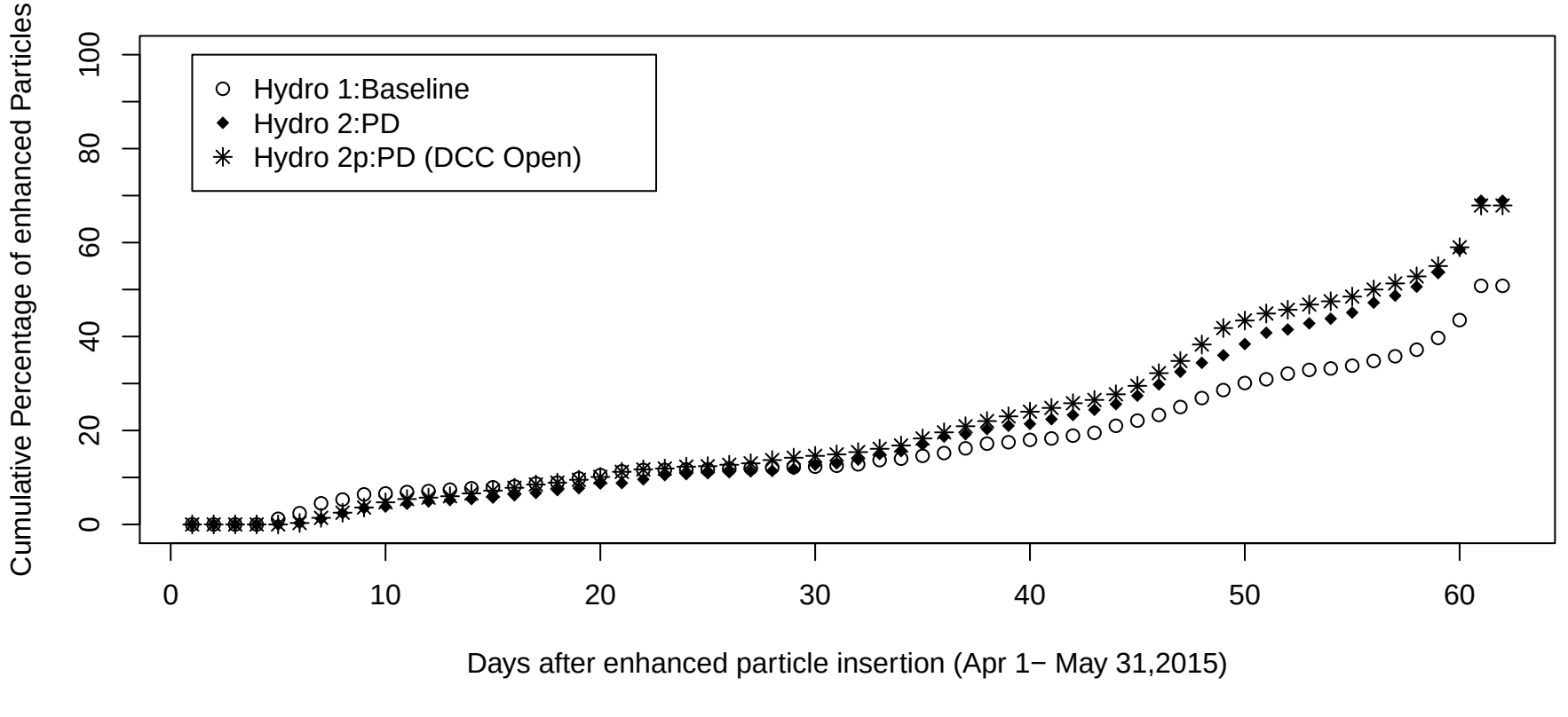
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= Sacramento R. at Sac, Node=Prisoner's Pt.
No Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
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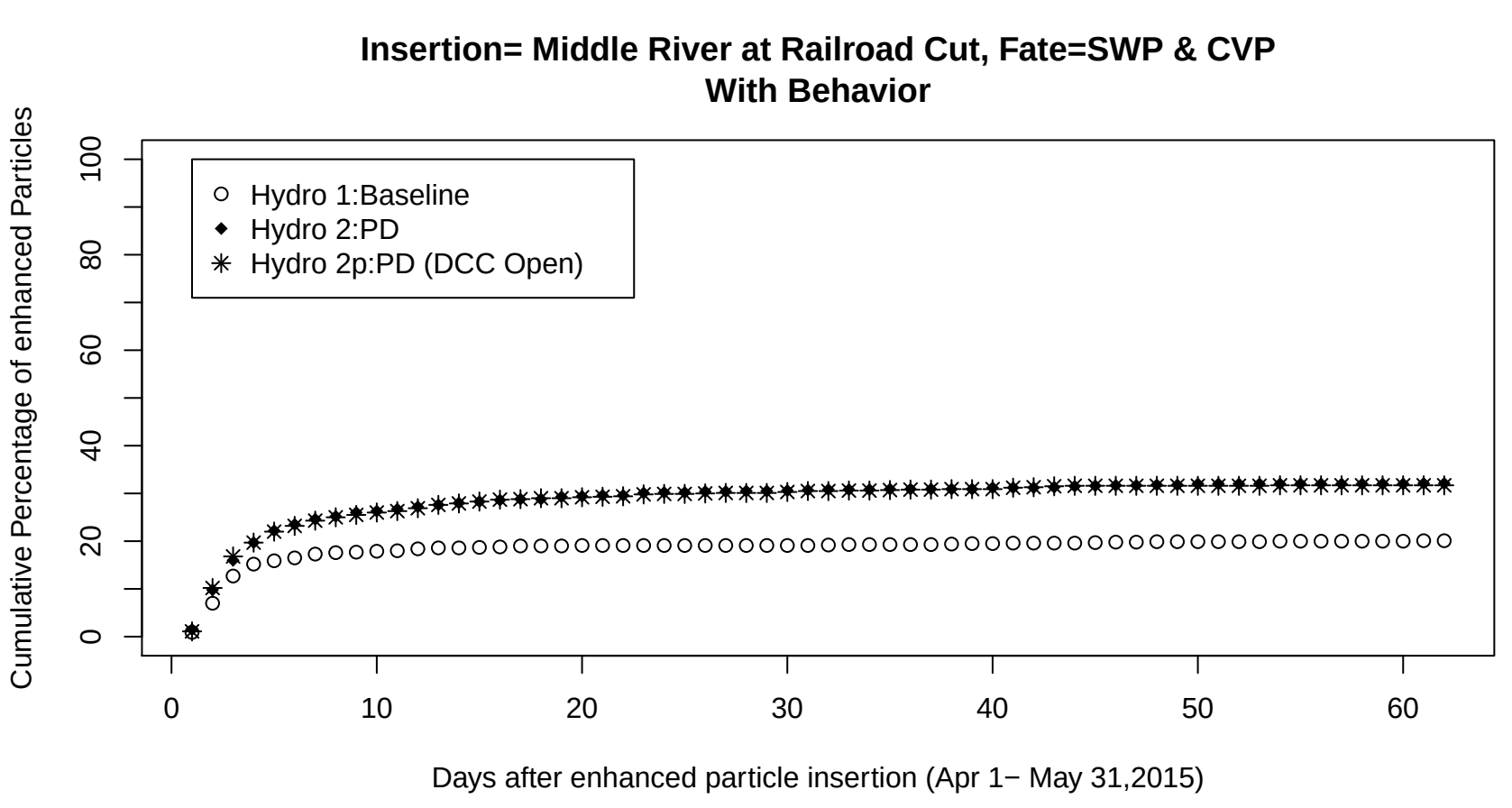
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= Middle River at Railroad Cut, Fate=SWP & CVP
With Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
0
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0
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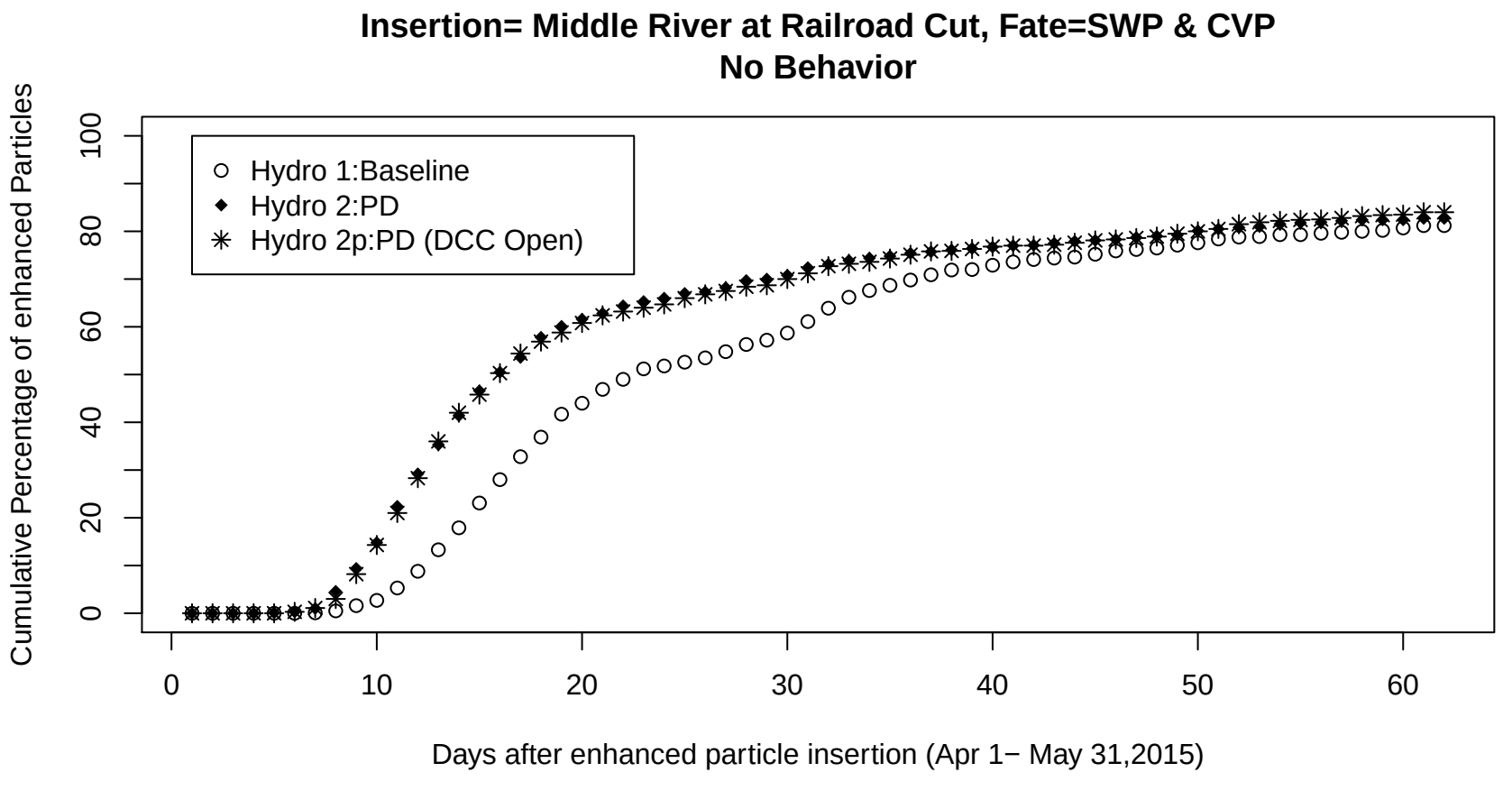
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= Middle River at Railroad Cut, Fate=SWP & CVP
No Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
0
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100
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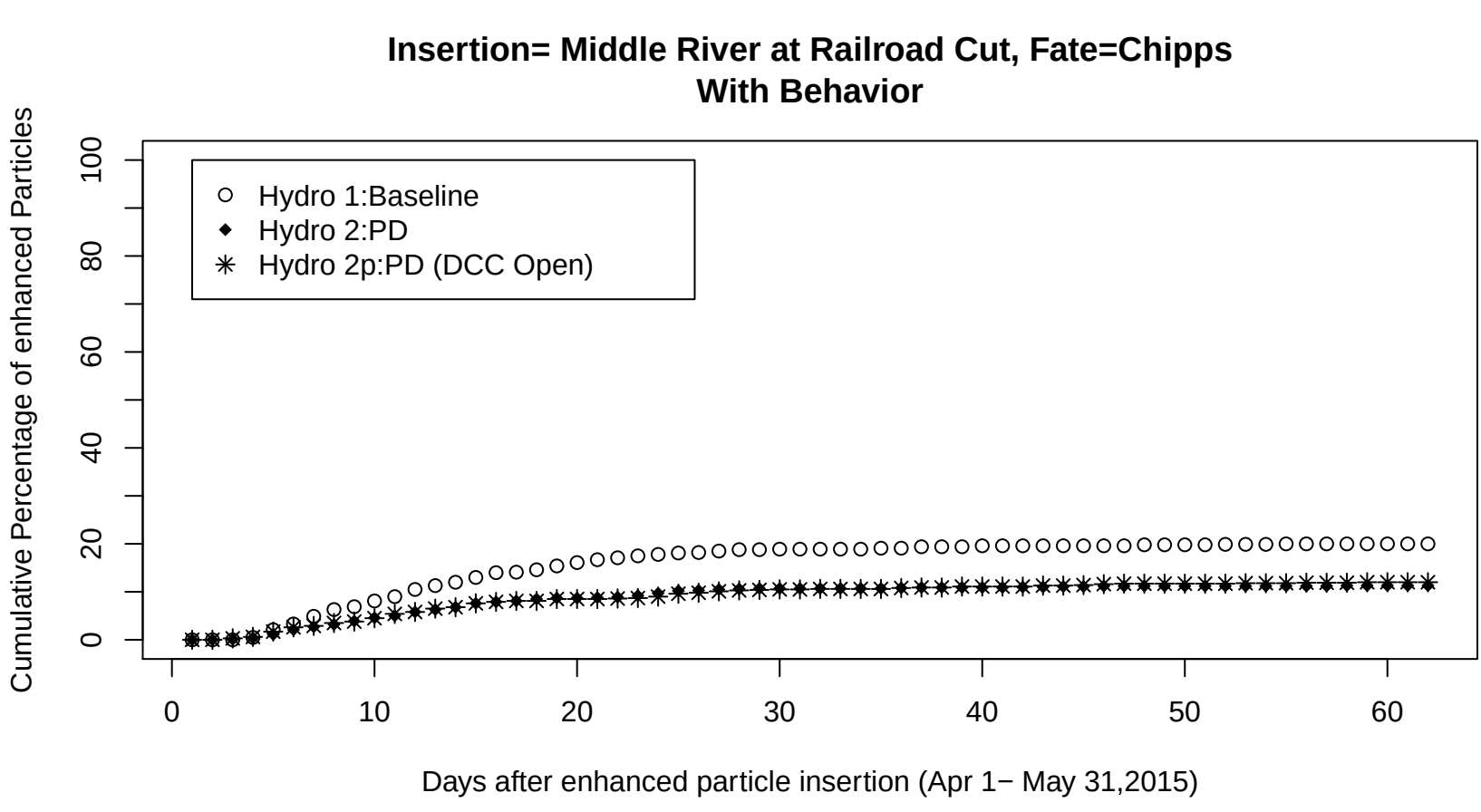
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= Middle River at Railroad Cut, Fate=Chipps
With Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
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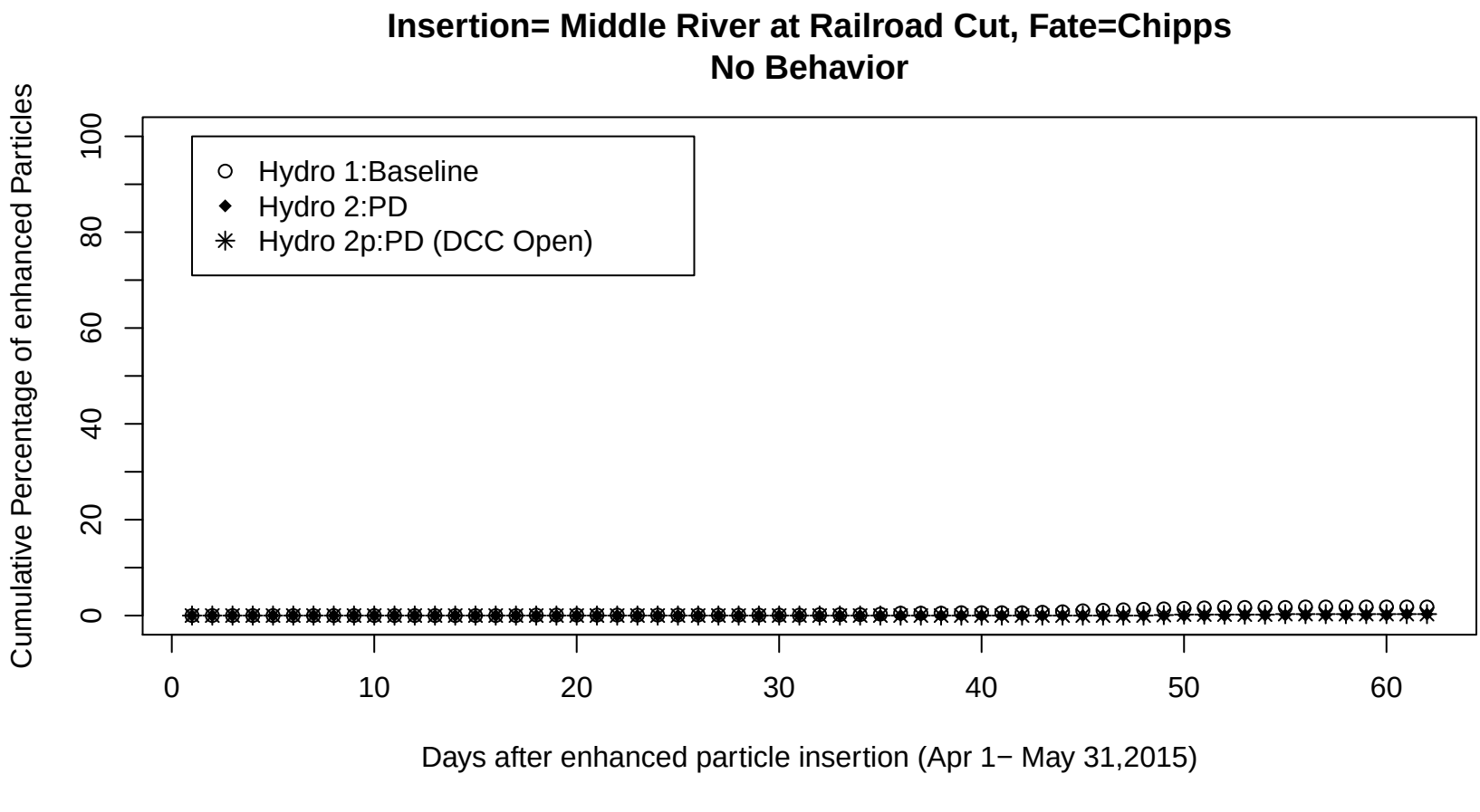
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= Middle River at Railroad Cut, Fate=Chipps
No Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
0
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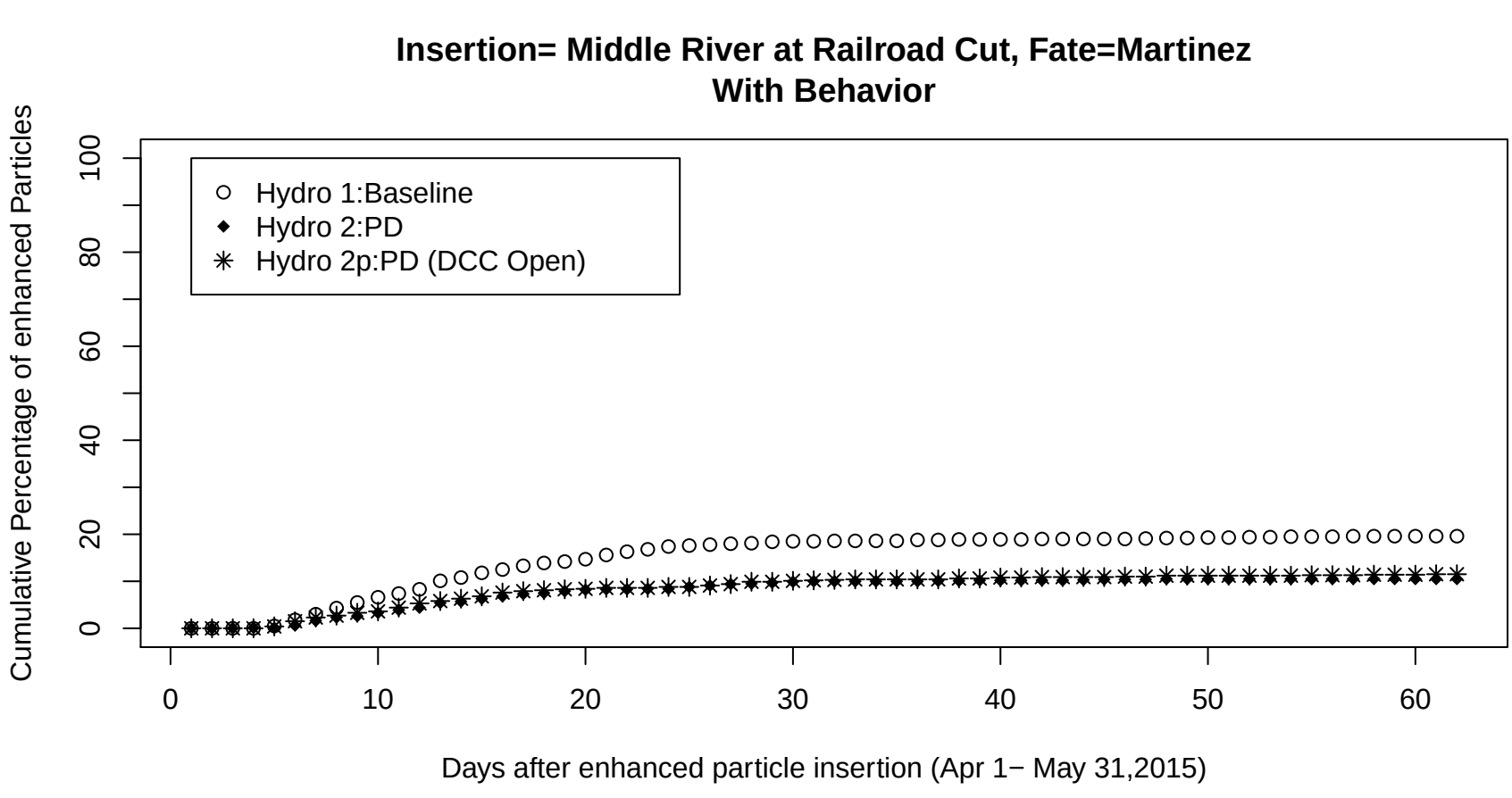
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= Middle River at Railroad Cut, Fate=Martinez
With Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
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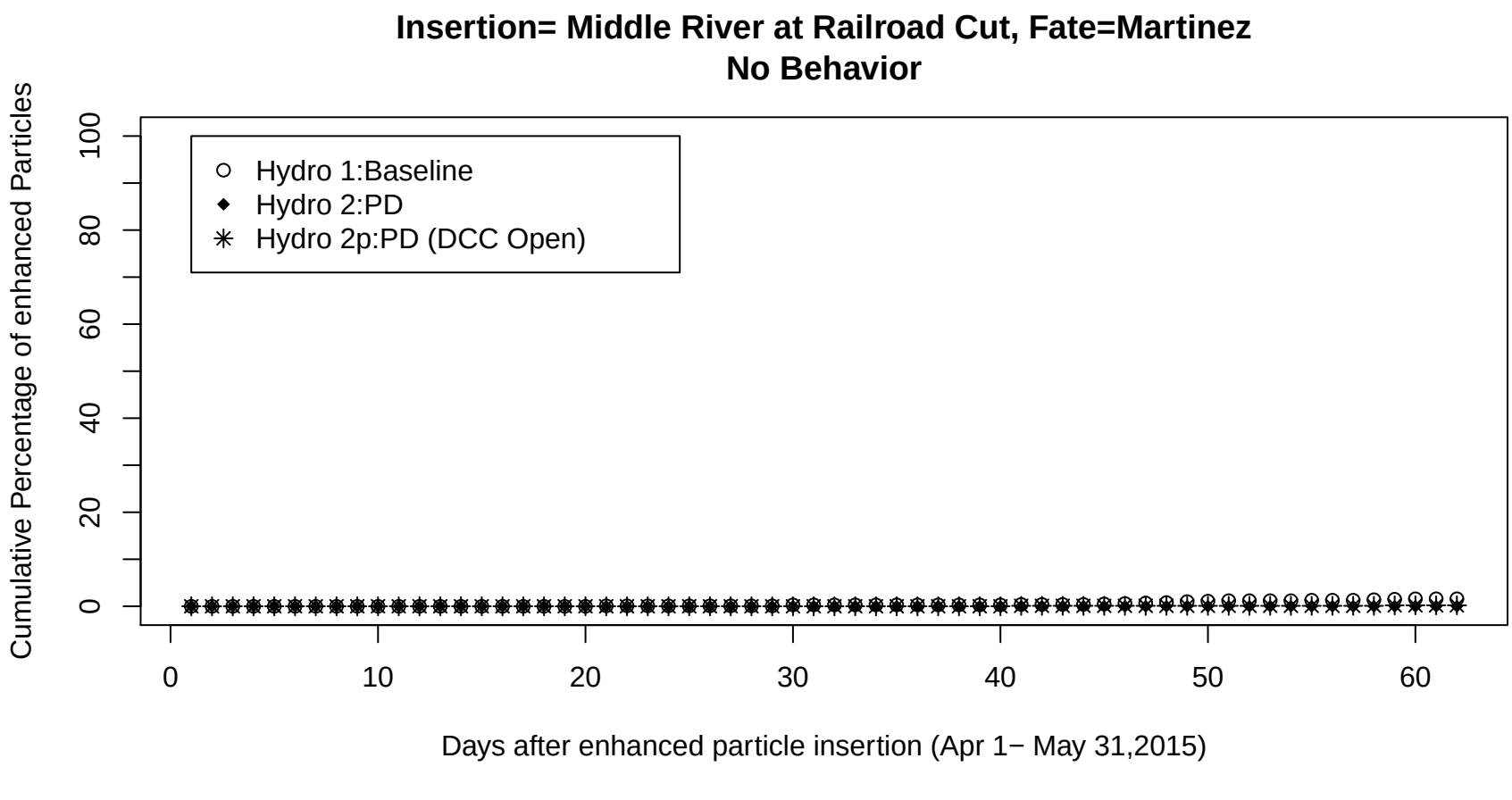
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= Middle River at Railroad Cut, Fate=Martinez
No Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
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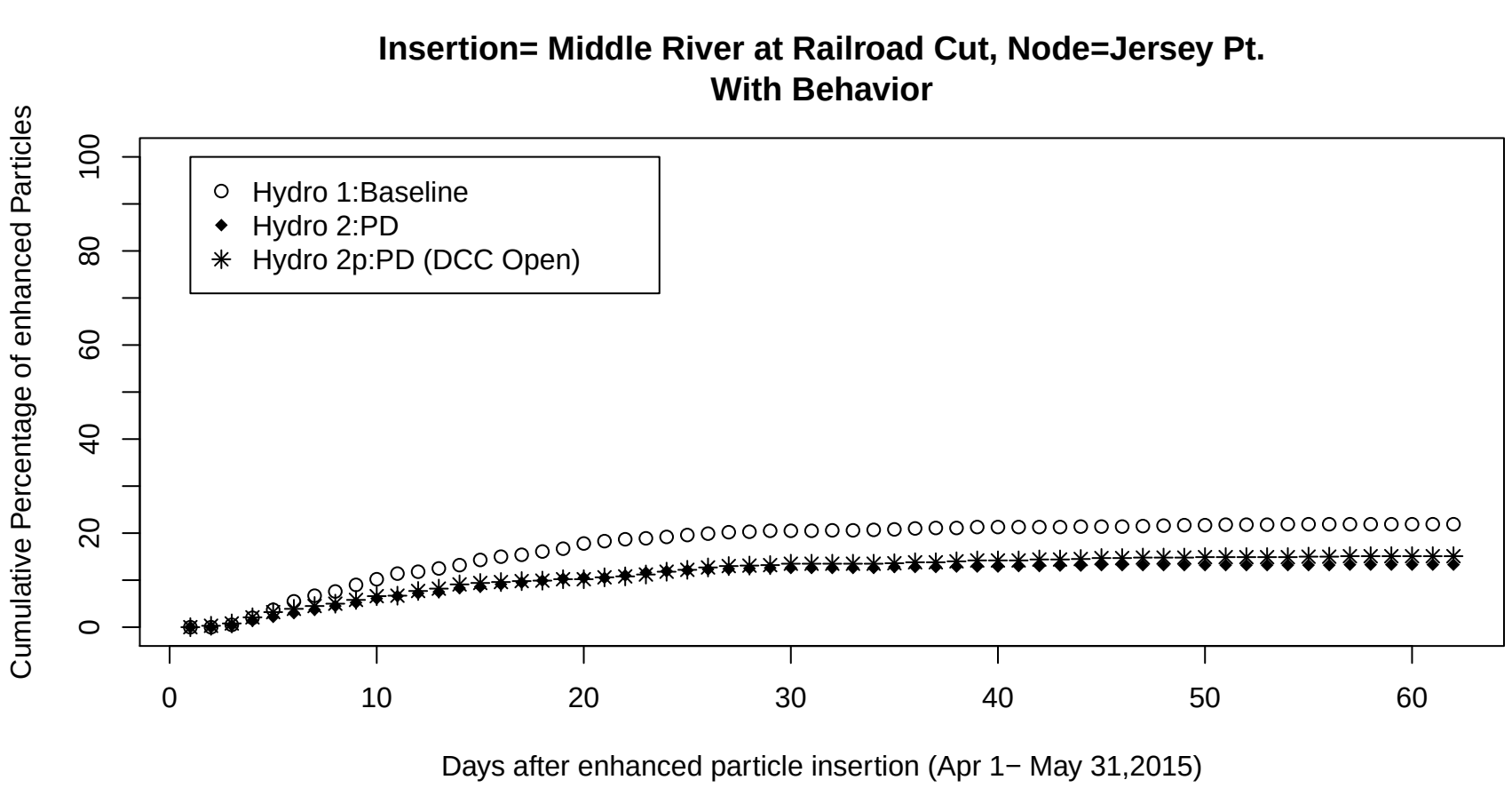
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= Middle River at Railroad Cut, Node=Jersey Pt.
With Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
0
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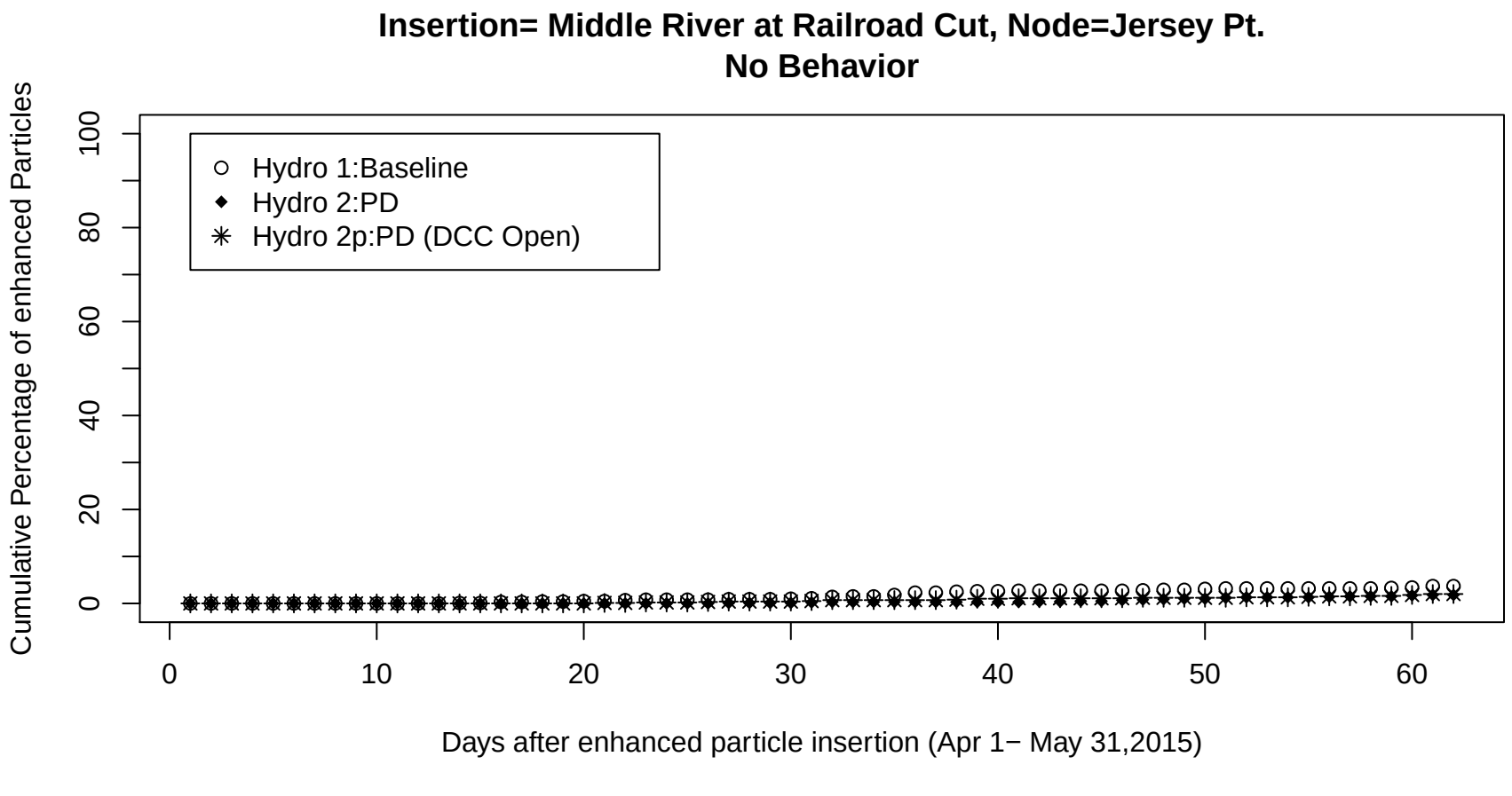
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= Middle River at Railroad Cut, Node=Jersey Pt.
No Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
0
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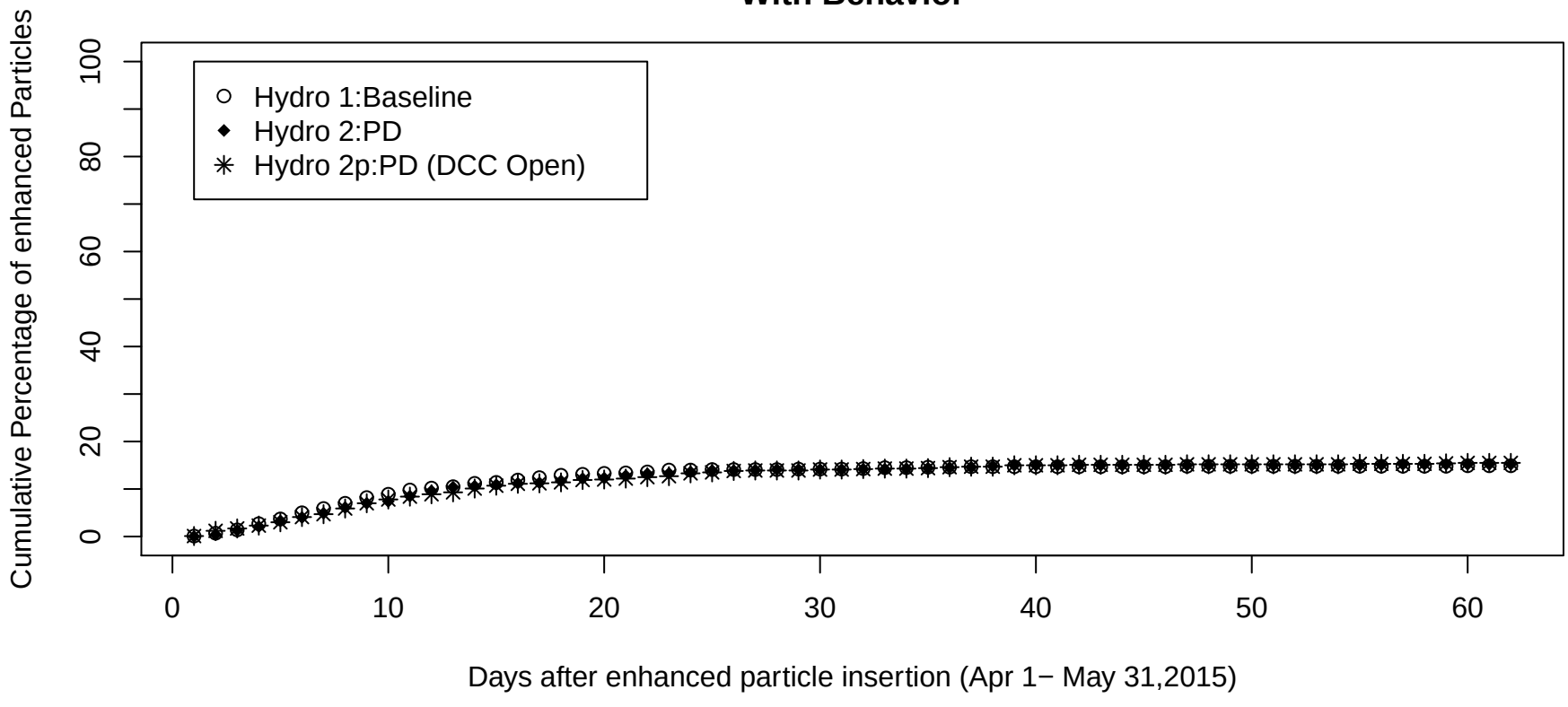
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= Middle River at Railroad Cut, Node=Prisoner's Pt.
With Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
0
20
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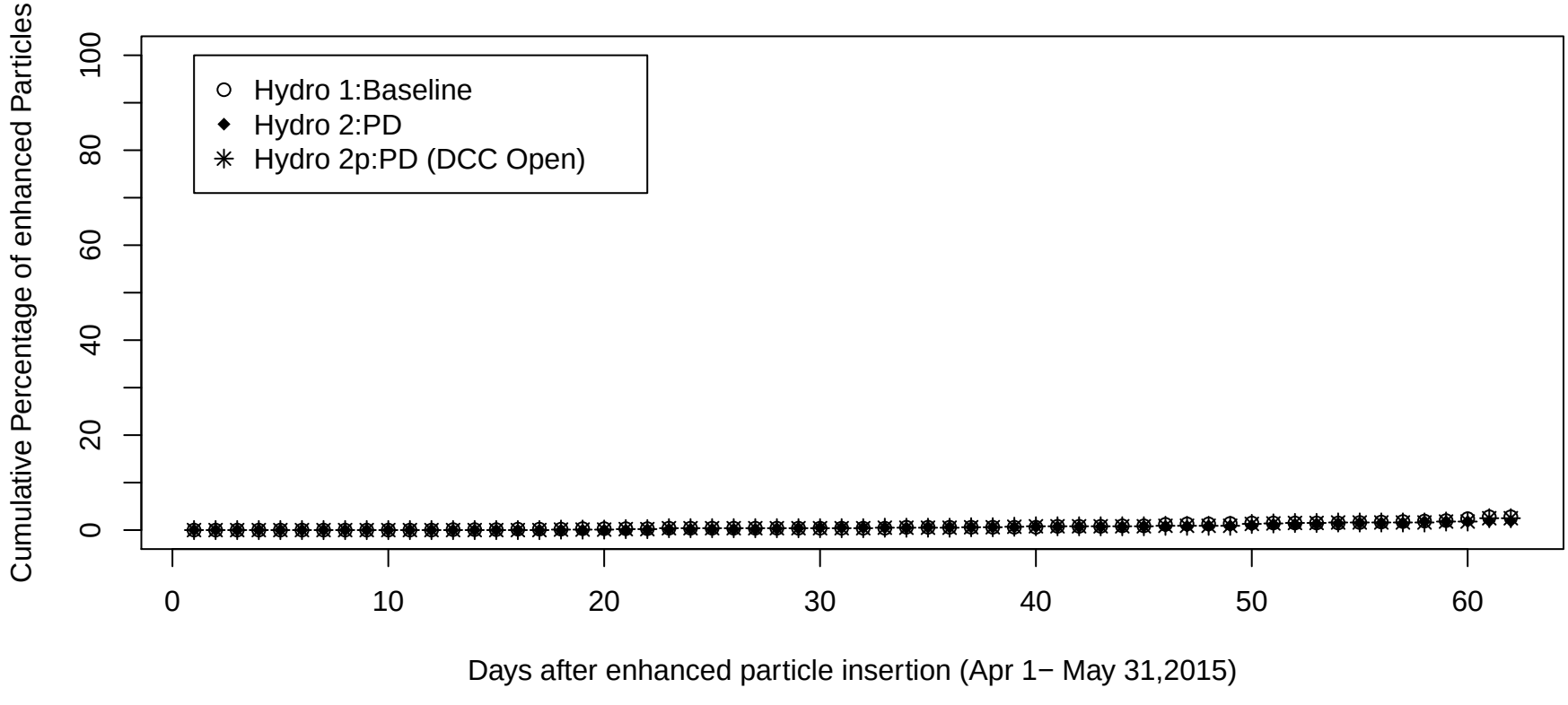
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= Middle River at Railroad Cut, Node=Prisoner's Pt.
No Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
0
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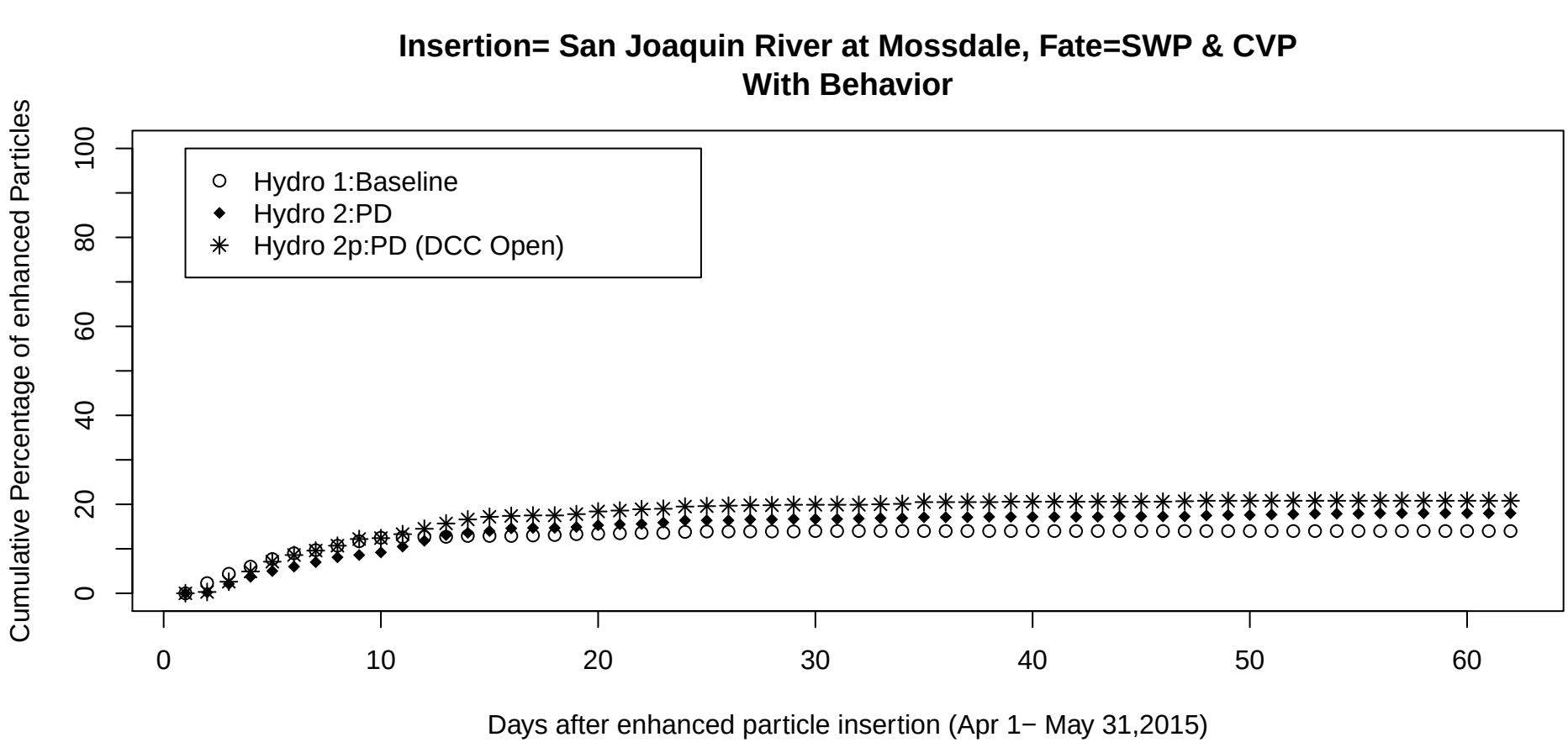
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= San Joaquin River at Mossdale, Fate=SWP & CVP
With Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
0
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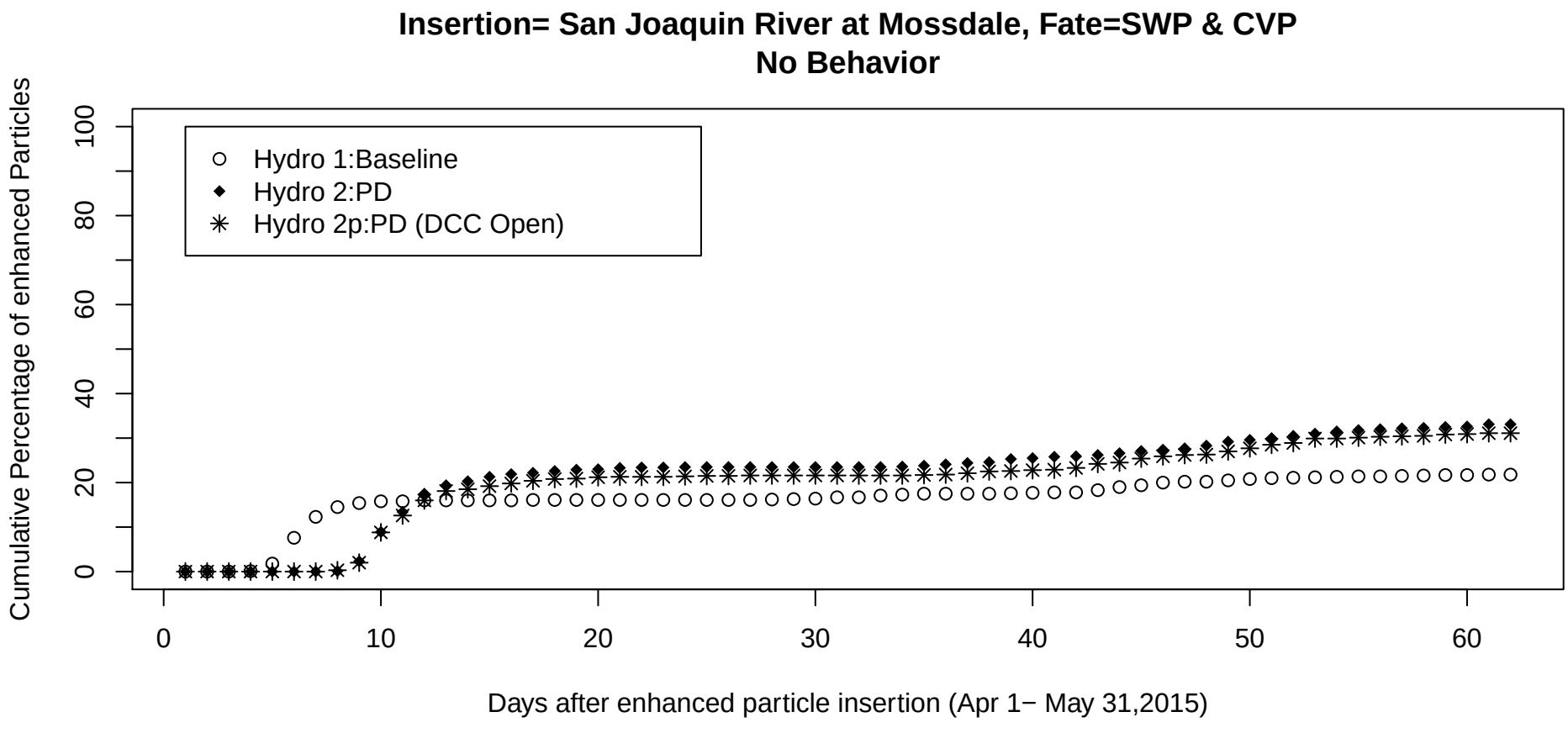
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= San Joaquin River at Mossdale, Fate=SWP & CVP
No Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
0
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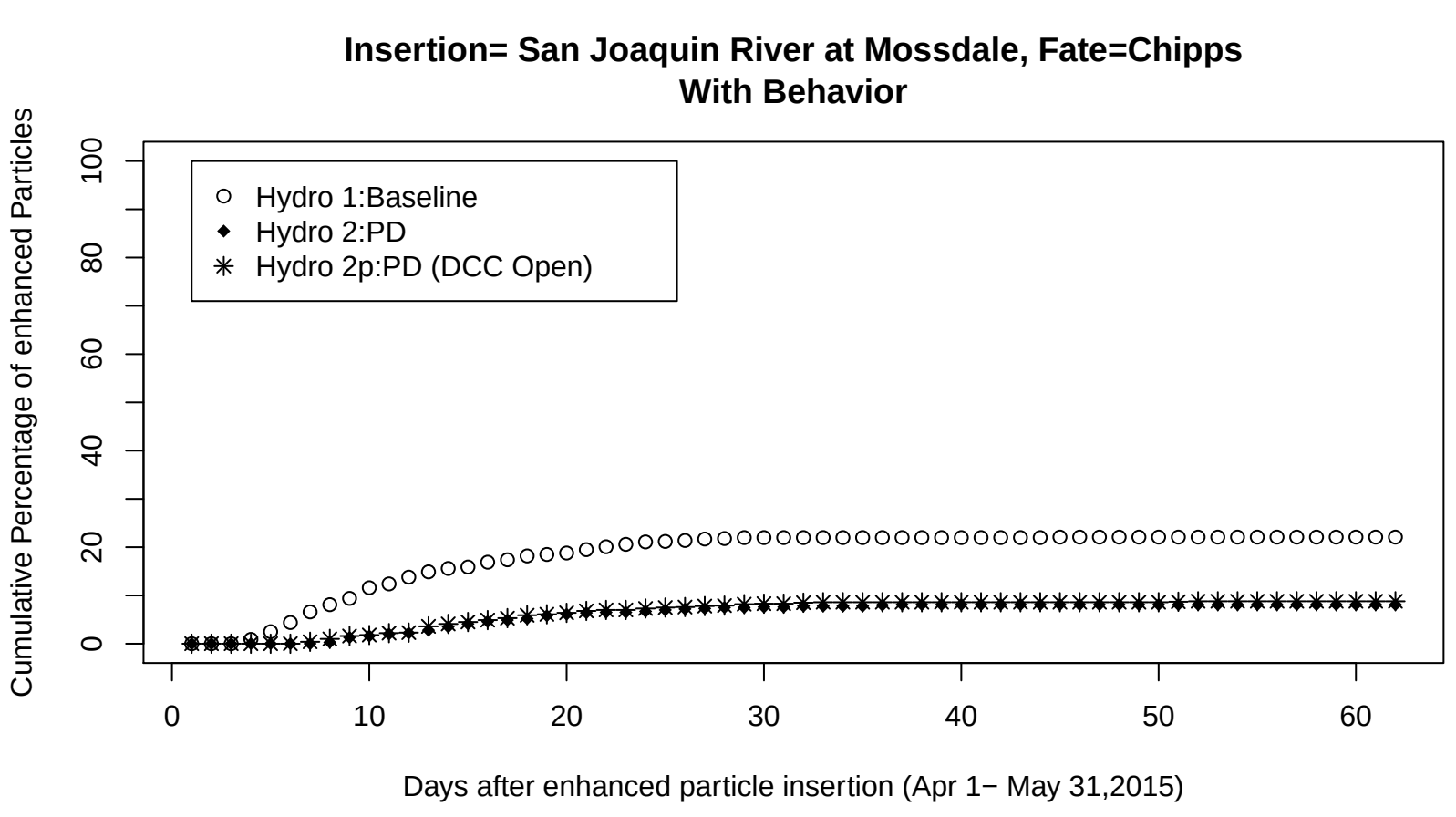
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= San Joaquin River at Mossdale, Fate=Chipps
With Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
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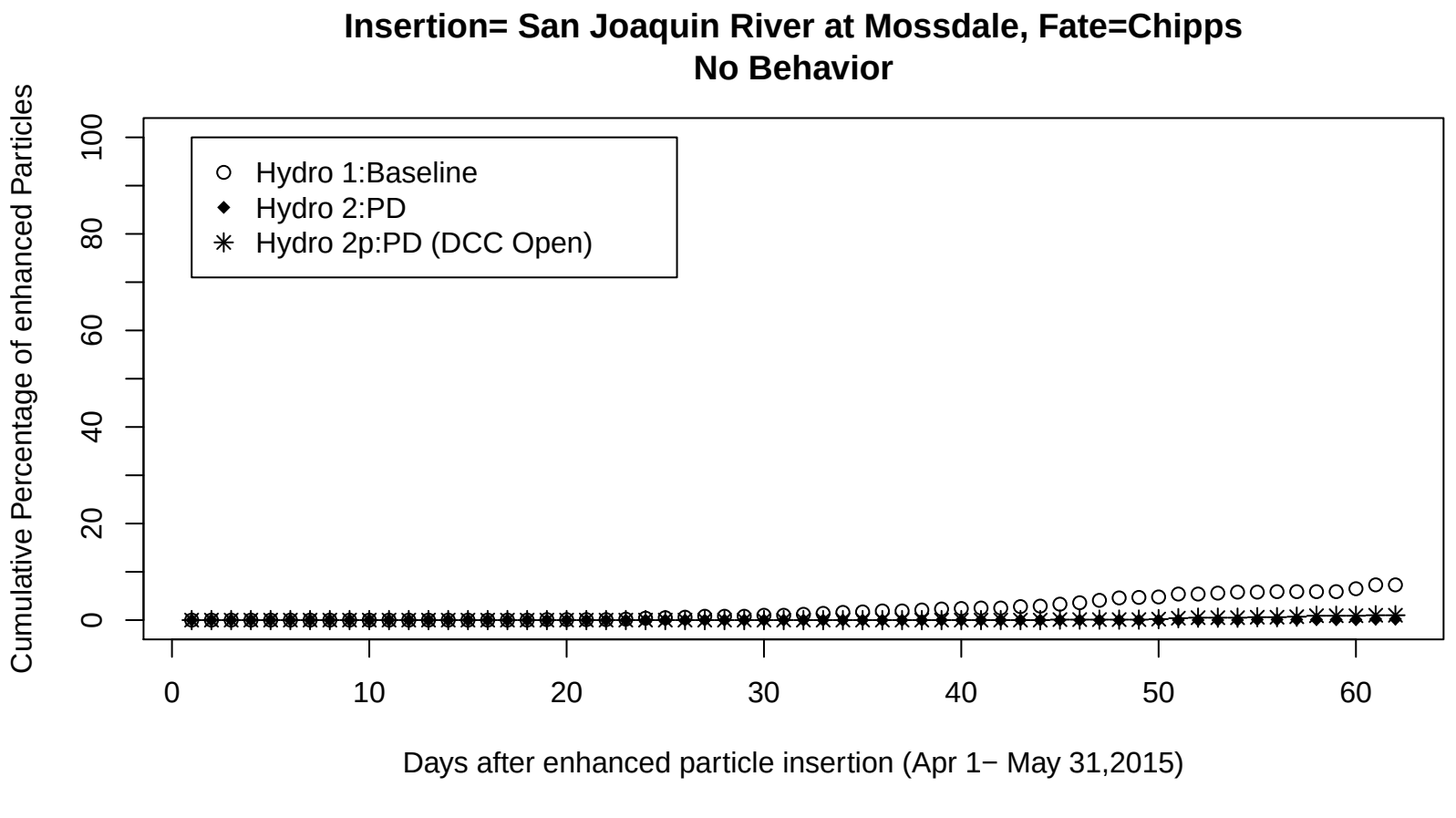
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= San Joaquin River at Mossdale, Fate=Chipps
No Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
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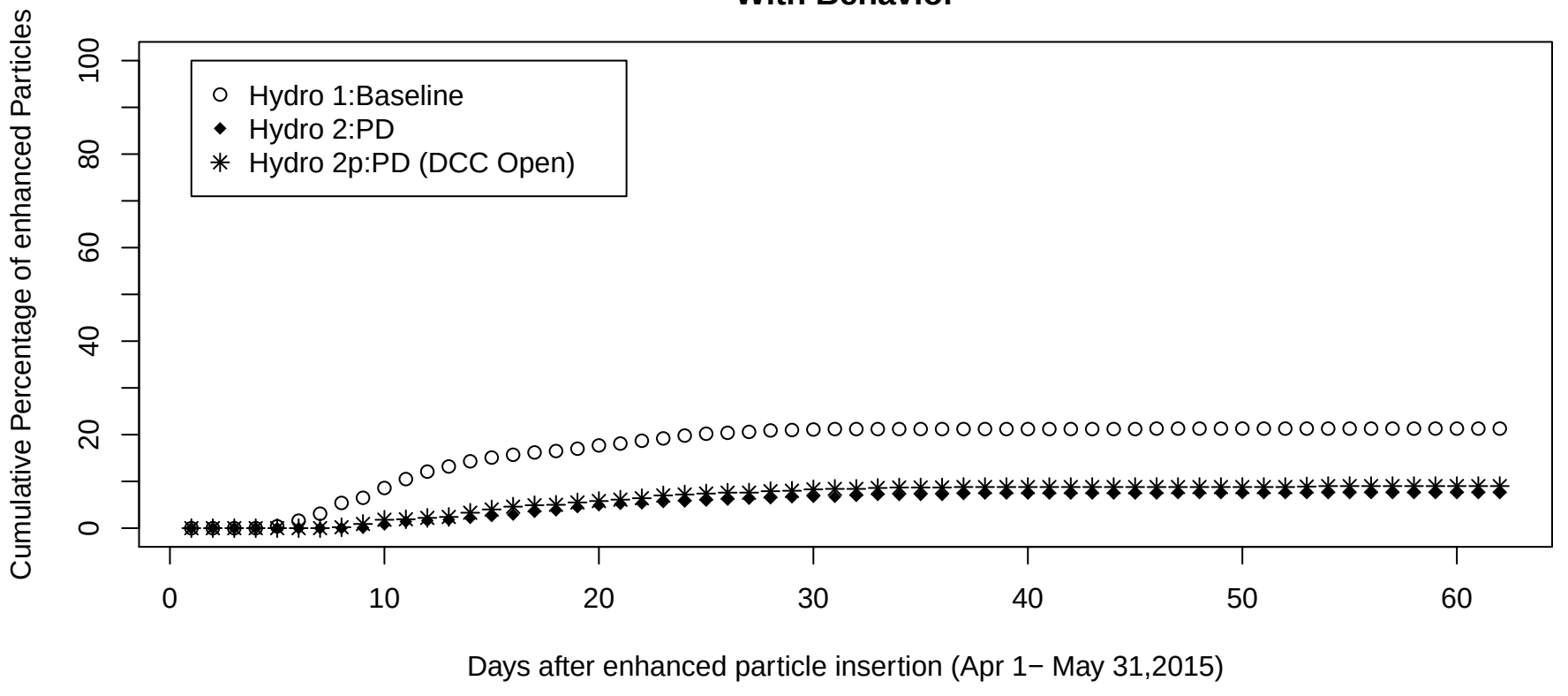
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= San Joaquin River at Mossdale, Fate=Martinez
With Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
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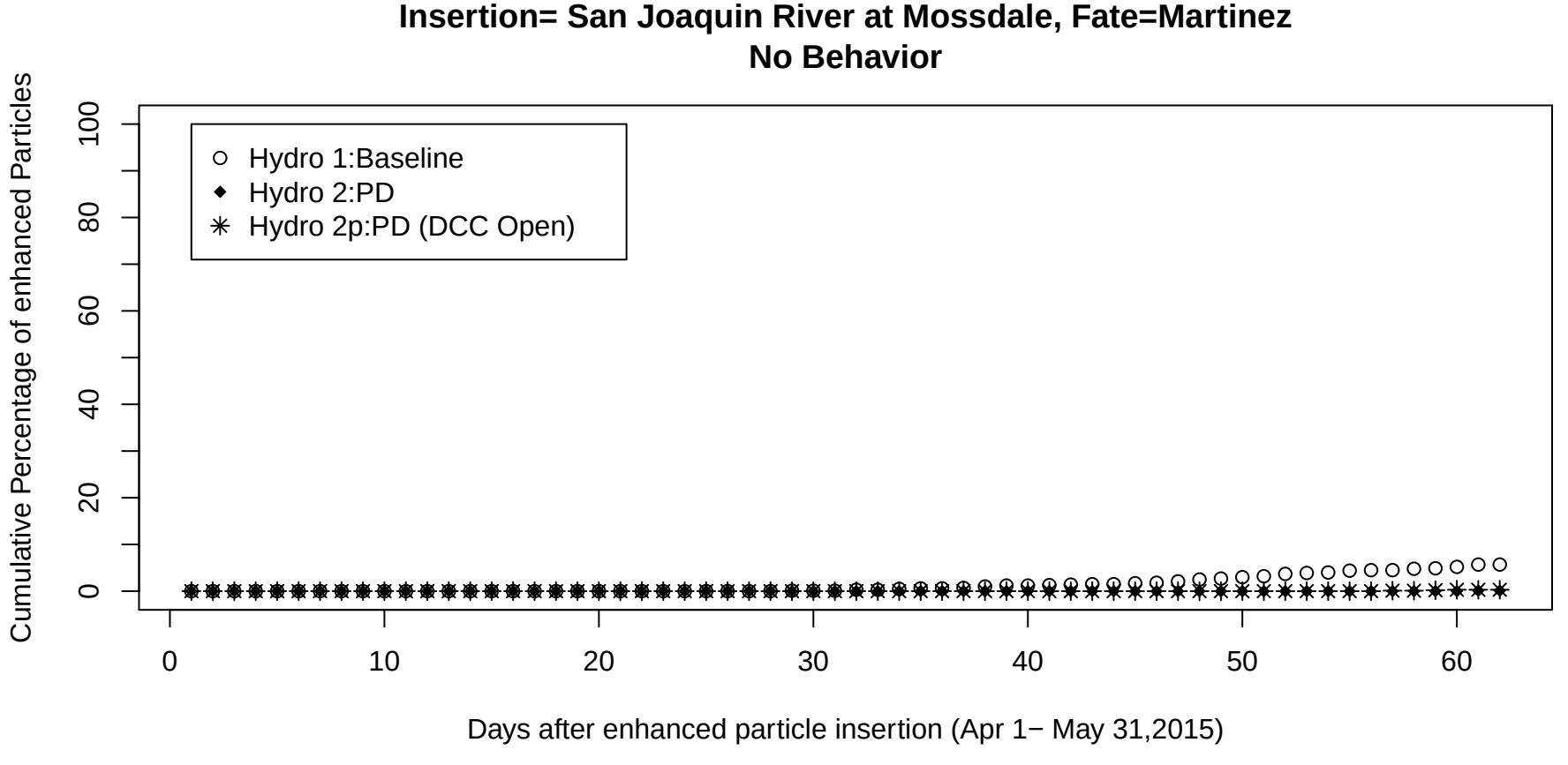
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= San Joaquin River at Mossdale, Fate=Martinez
No Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
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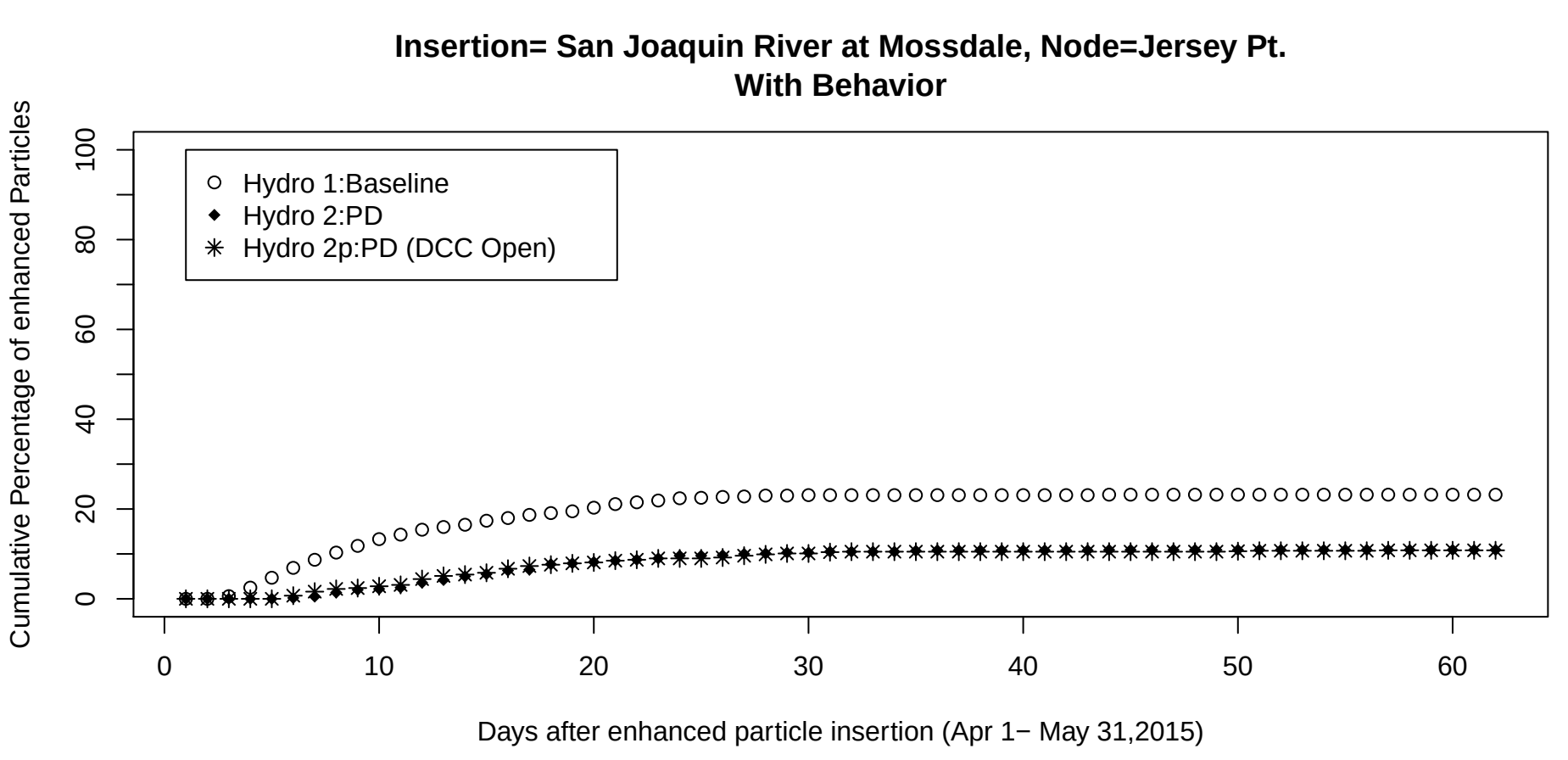
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= San Joaquin River at Mossdale, Node=Jersey Pt.
With Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
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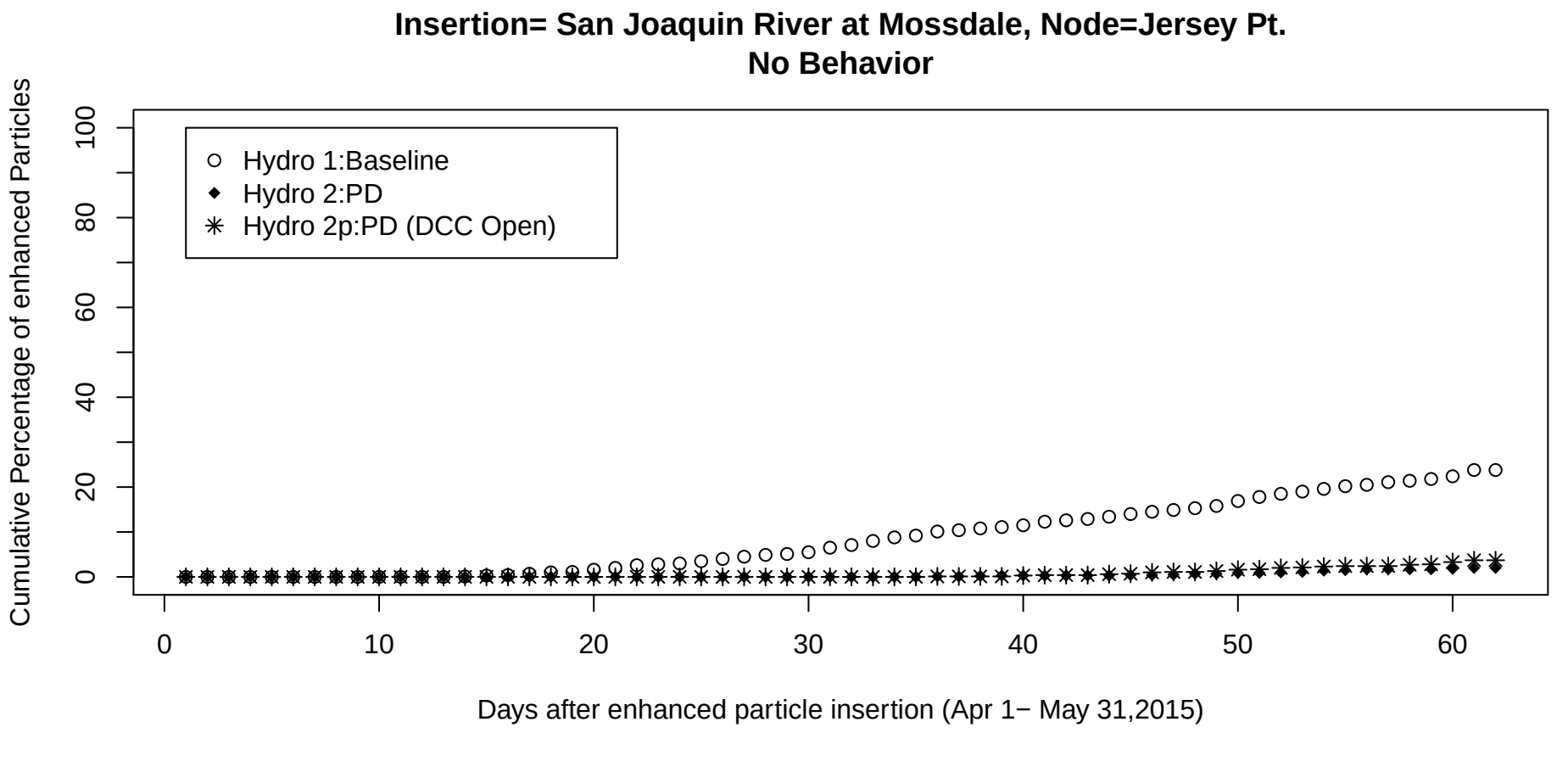
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= San Joaquin River at Mossdale, Node=Jersey Pt.
No Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
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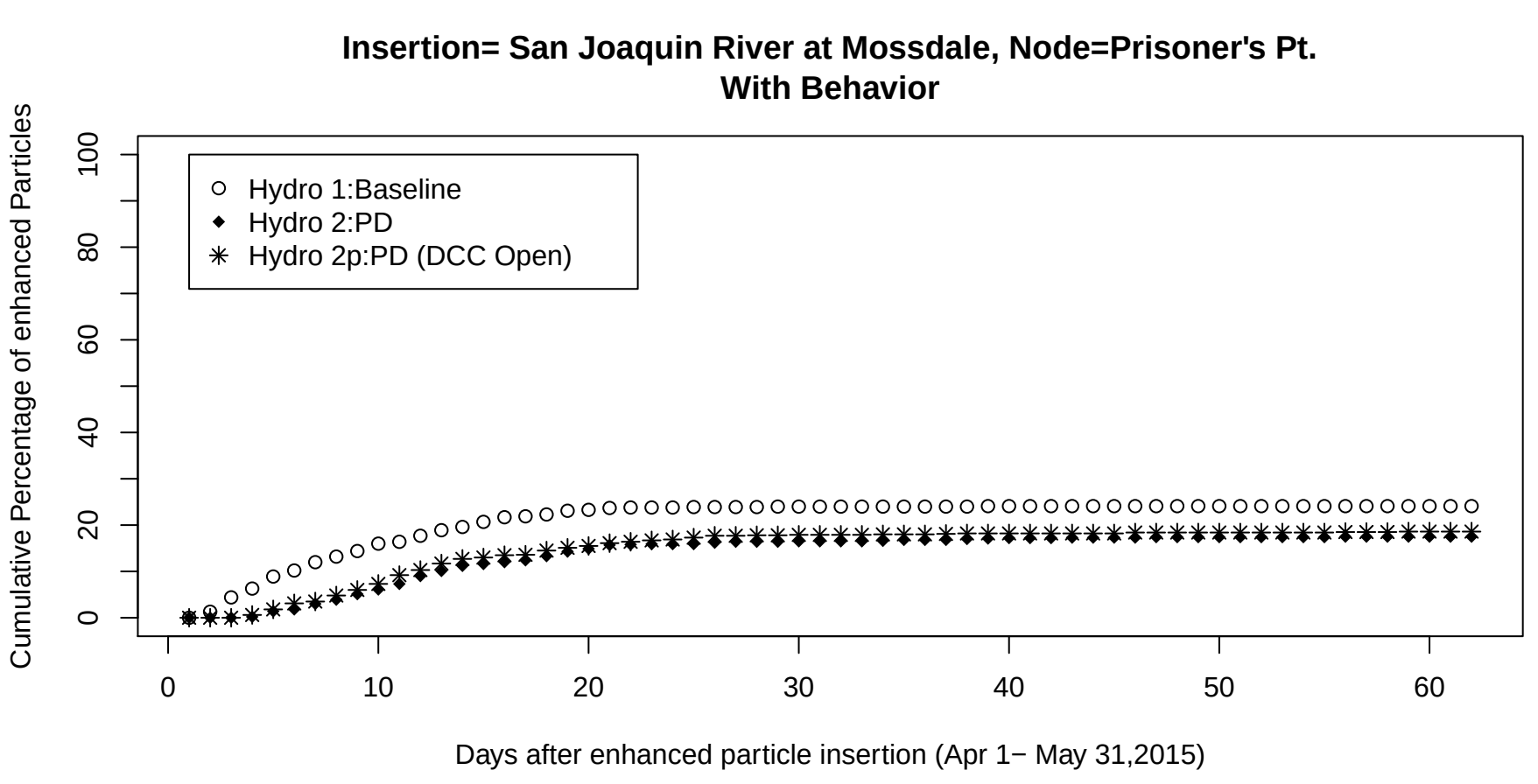
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= San Joaquin River at Mossdale, Node=Prisoner's Pt.
With Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
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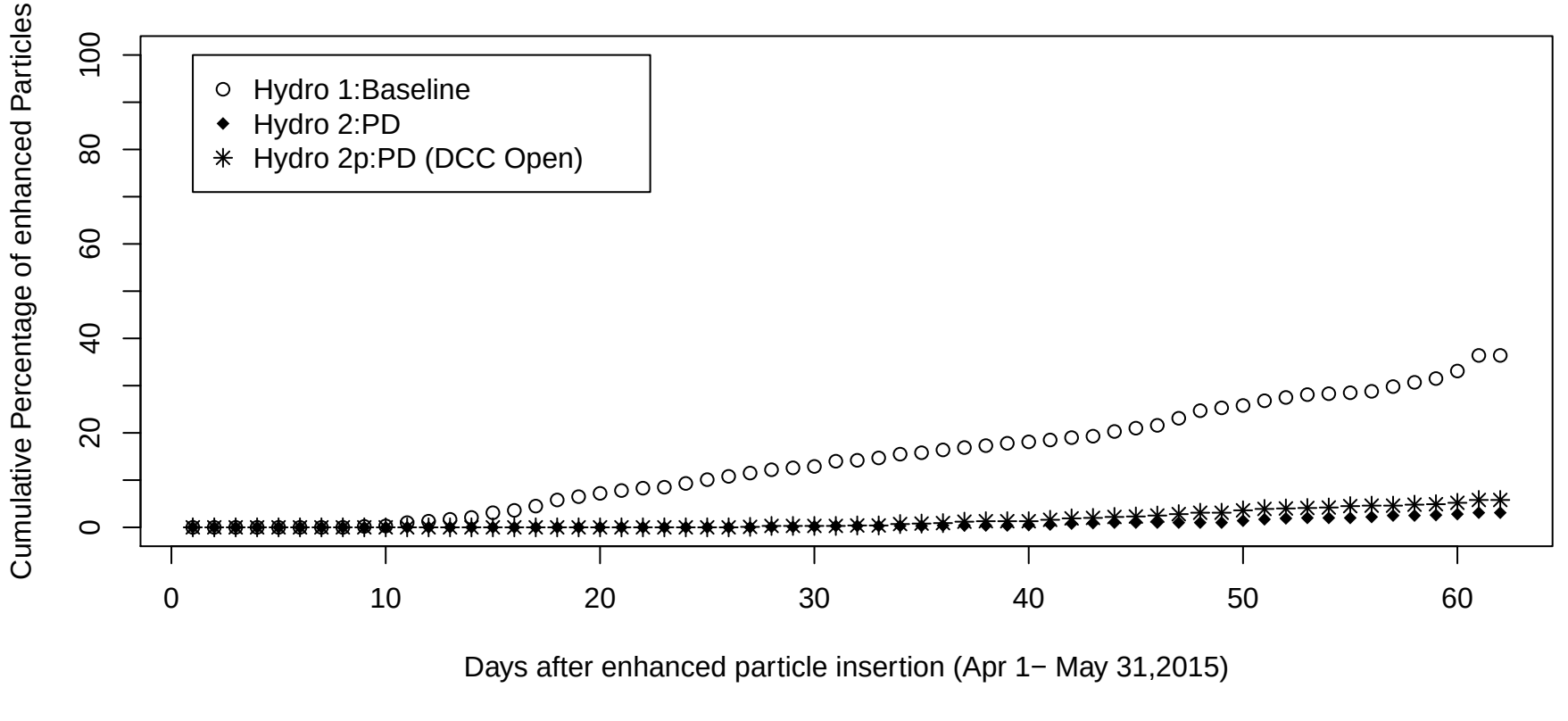
Days after enhanced particle insertion (Apr 1− May 31,2015)


Insertion= San Joaquin River at Mossdale, Node=Prisoner's Pt.
No Behavior
Hydro 1:Baseline
Hydro 2:PD
Hydro 2p:PD (DCC Open)
Cumulative Percentage of enhanced Particles
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Days after enhanced particle insertion (Apr 1− May 31,2015)

"Null" PTM results (3/23/15) for TUCP April - September

For comparison with ePTM results – NO behavior and NO mortality.

Glossary:

Insertion location: refers to a location where the particles are inserted into the model. The insertion location can change based on monitoring information and so as to reflect the current understanding of species distribution.

Scenario: refers to the hydrologic conditions as described in the DSM2 output file which are used as the basis of conditions in the PTM.

Fate: refers to a particular location at a given time in the model. Some fates are "terminal," meaning once a particle reaches a terminal fate they are removed from the model (i.e. CVP, SWP or exiting the Delta)

Exit: refers to the geographic limit of the model. In the case of the Delta and DSM2, exit refers to those particles that have passed Martinez.

Other Mortality: *Not applicable in the "null" PTM runs.*

In System: refers to proportion of particles that did not reach a terminal fate and did not expire by the end of the model run.

Model parameters:

The model parameters follow the hydrologic conditions described in Table 1 that was provided with Reclamation's Biological Review. Three separate insertion locations were used for the PTM runs of the Baseline, the Project Description (DCC gate closed), and Project Description (DCC gate open) scenarios during which 1000 particles were "inserted" into the model on April 1. Each model was then run until June 2 (60 days after insertion).

Table 1.DSM2 Model input for scenarios evaluated in the biological review. DSM2 run name is listed parenthetically for each scenario.

Scenario	NDOI		Freeport flow (cfs)		Vernalis flow (cfs)		Combined Exports (cfs)		DCC Status
	April	May	April	May	April	May	April	May	
Baseline (Hydrology 1)	7,100		7,100- (VNS +export)		710 +3100 cfs (4/1 -5/1)		1,500		Closed
Project Description – DCC Gate Closed (Hydrology 2)	4,000		4,000-(Lower VNS +export)		300+App. 2e flow (4/1 – 5/1)[1]		1,500		Closed
Project Description -- DCC Gate Open (Hydrology 2')	4,000		4,000-(Lower VNS +export)		300+App. 2e flow (4/1 – 5/1)[1]		1,500		Open for 2 months

[1] The TUCP identifies proposed modification of the average monthly flow during the Vernalis 31-day pulse flow period to be no less than 710 cfs.

Particle Fate:

Table 1a: Sacramento particle fate as a proportion of 1000 particle "release." Baseline, Project Description (DCC gate closed), and Project Description (DCC gate open) scenarios, April 1, 2015 – June 2, 2015, (60 Days) Insertion: Sherwood Harbor (DSM2 node 332)

Sacramento Start	Jersey Point	Prisoners Point	Chipps	CVP & SWP	Exit	Other Mort	In system	Total
Baseline (Hydro 1)	61.00%	50.80%	32.40%	0.40%	41.90%	0.00%	57.70%	100.00%
PD Hydro 2	57.80%	68.90%	22.10%	1.50%	22.80%	0.00%	75.70%	100.00%
PD Hydro 2' (DCC open)	56.20%	67.90%	17.60%	0.80%	19.20%	0.00%	80.00%	100.00%

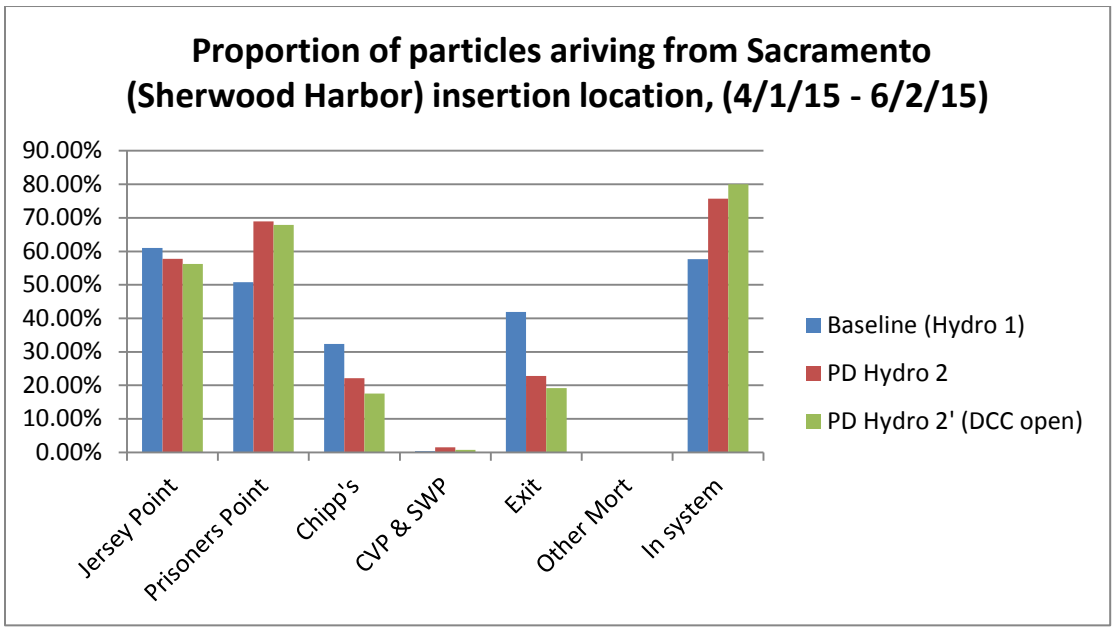

Table 1b: Central/South Delta particle fate as a proportion of 1000 particle "release." Baseline, Project Description (DCC gate closed), and Project Description (DCC gate open) scenarios, April 1, 2015 – June 2, 2015, (60 Days) Insertion: Middle River at Railroad Cut (DSM2 node 121, SWFSC real time receiver location)

Middle River	Jersey Point	Prisoners Point	Chipps	CVP & SWP	Exit	Other Mort	In system	Total
Baseline (Hydro 1)	3.70%	2.80%	1.80%	81.20%	1.60%	0.00%	17.20%	100.00%
PD Hydro 2	1.80%	1.90%	0.30%	82.70%	0.00%	0.00%	17.30%	100.00%
PD Hydro 2' (DCC open)	2.00%	2.50%	0.30%	84.00%	0.20%	0.00%	15.80%	100.00%

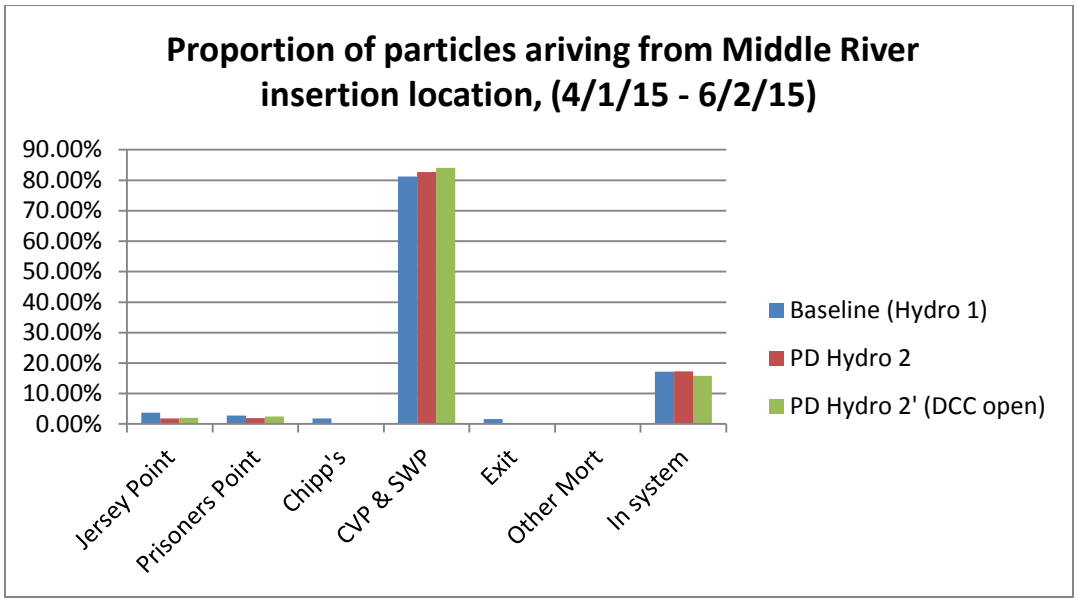

Table 1c: San Joaquin particle fate as a proportion of 1000 particle "release." Baseline, Project Description (DCC gate closed), and Project Description (DCC gate open) scenarios, April 1, 2015 – June 2, 2015, (60 Days) Insertion: Mossdale Crossing (DSM2 node 6)

Mossdale	Jersey Point	Prisoners Point	Chipps	CVP & SWP	Exit	Other Mort	In system	Total
Baseline (Hydro 1)	23.80%	36.40%	7.30%	21.80%	5.70%	0.00%	72.50%	100.00%
PD Hydro 2	2.00%	3.10%	0.20%	33.10%	0.10%	0.00%	66.80%	100.00%
PD Hydro 2' (DCC open)	3.70%	5.80%	1.00%	31.10%	0.30%	0.00%	68.60%	100.00%